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ONE-HUNDRED-AND-THIRTY-NINTH SESSION, 1892-93.

SESSIONAL ARRANGEMENTS.

The First Meeting of the One Hundred and Thirty-ninth Session of the Society was held on Wednesday, the 16th November, when the Opening Address was delivered by Sir Richard Webster, Q.C., M.P., Chairman of the Council. The following arrangements have been made for the four meetings before Christmas :—

November 23.—F. Seymour Haden, F.R.C.S., "Cremation as an Incentive to Crime." Dr. George Vivian Poore, M.D., F.R.C.P., will preside.

" 30.—James Douglas, "The Copper Resources of the United States." Sir I. Lowthian Bell, Bart., F.R.S., will preside.

DECEMBER 7.—JAMES DREDGE, "The Chicago Exhibition, 1893." Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., will preside.

,, 14.—PROF. GEORGE FORBES, F.R.S., "The Utilisation of Niagara." SIR RICHARD WEBSTER, Q.C., M.P., will preside.

Papers for meetings after Christmas :—

BENNETT H. BROUGH, "The Mining Industries of South Africa."

PROF. FRANK CLOWES, D.Sc., "The Detection and Estimation of small proportions of Inflammable Gas or Vapour in the Air."

WILLIAM KEY, "The Purification of the Air Supply to Public Buildings and Dwellings."

WILTON P. RIX, "Pottery Glazes, their Classification and Decorative Value in Ceramic Design."

PROF. W. NOEL HARTLEY, F.R.S., "The Chemical Technology of Oil Boiling, with a description of a New Process for the Preparation of Drying Oils, and an Oil Varnish."

PROF. FRANCIS ELGAR, LL.D., "Transatlantic Steamships."

SIR WILLIAM WILSON HUNTER, K.C.S.I., C.I.E., LL.D., "Ten Years of Progress in India."

SIR EDWARD N. C. BRADDON, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisation."

SIR JULAND DANVERS, K.C.S.I., late Public Works Secretary, India-office, "Indian Manufactures."

JERVOISE ATHELSTANE BAINES, I.C.S., Imperial Census Commissioner for India, "Caste and Occupation at the last Census of India."

EDWARD J. HOWELL, "Mexico, Past and Present."

CECIL FANE, "Newfoundland."

W. B. PERCIVAL, Agent-General for New Zealand, "New Zealand."

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday Afternoons, at Half-past Four o'clock :—

January 19, February 16, March 9, April 6, 27, May 11.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four or Eight o'clock :—

January 17, February 28, March 21, April 18, May 2, 16.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

January 24, February 7, 21, March 14, April 11, May 9.

CANTOR LECTURES.

These lectures will be delivered on the following Monday evenings, at Eight o'clock :—

PROF. VIVIAN LEWES, "Generation of Light from Coal Gas." Four Lectures.

LECTURE I.—NOVEMBER 21.—An Experimental Review of the Researches of the Century upon Flame and its Luminosity—The Work of Sir Humphry Davy, and the Researches between 1820 and 1860.

LECTURE II.—NOVEMBER 28.—The Researches of Frankland, Stein, Heumann, Soret, and Burch—The Chemical Changes taking place in a Luminous Flame.

LECTURE III.—DECEMBER 5.—Theories of Luminosity as they at present exist—The Genesis of the Gas Burner—Flat Flames, Argands, Regenerative and Incandescent Burners—The Gas Burner in Relation to the Gas to be Burned.

LECTURE IV.—DECEMBER 12.—The effect of the Constituents of the Atmosphere on the Light emitted by Flames—The probable Limit of Light to be obtained from Gas—The Measurement of Light.

DR. J. A. FLEMING, "The Practical Measurement of Alternating Electric Currents." Four Lectures.

January 30, February 6, 13, 20.

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Three Lectures.

March 6, 13, 20.

LEWIS FOREMAN DAY, "Some Masters of Ornament." Four Lectures.

April 10, 17, 24, May 1.

C HARRISON TOWNSEND, F.R.I.B.A., "The History and Practice of Mosaics." Two Lectures.

May 8, 15.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday Evenings, at Eight o'clock :—

PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

January 13, 20, 27, February 3, 10, 17.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered on Wednesday evenings, January 4 and 11, 1893, at 7 p.m.

CHICAGO EXHIBITION, 1893.

The Council of the Society has been appointed a Royal Commission for the Chicago Exhibition, 1893. All applications for space in the British Section, and all inquiries for information about the Exhibition, should be addressed to the Secretary of the Royal Commission, Society of Arts, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom ; and for meritorious works in the various departments of the Fine Arts ; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts ; for the application of such natural and artificial products, whether of Home, Colonial, of Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce ; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

THE SESSION.—The Session commences in November, and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session, paper on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies, and with Foreign Countries. Six or more Meetings are held during the Session.

APPLIED ART SECTION.—This Section was formed in 1886, for the discussion of subjects connected with the industrial applications of the Fine Arts. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are several Courses every Session, and each course consists generally of two or more Lectures.

Additional Lectures.—Special Courses of Lectures are occasionally given.

Juvenile Lectures.—A short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

Admission to Meetings.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

Journal of the Society of Arts.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

Examinations.—Examinations are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal divisions of a Commercial Education, Domestic Economy, and Music. A Programme, containing detailed information about the Examinations, can be had on application to the Secretary.

Library and Reading-room.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

Conversazioni are held to which the Members are invited, each Member receiving a card for himself and a Lady.

MEMBERSHIP.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled:—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.
To be present and vote at all General Meetings of the Society.
To be present at the Cantor and other Lectures, and to introduce one visitor.
To have personal free admissions to all Exhibitions held by the Society at its house in the Adelphi.
To be present at all the Society's *Conversazioni*.
To receive a copy of the Weekly *Journal* published by the Society.
To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

All subscriptions should be paid to the Secretary, Sir Henry Trueman Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

HENRY TRUEMAN WOOD, *Secretary.*

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1892-93. It is issued subject to any necessary alterations:—

NOVEMBER, 1892.		
1	Tu	
2	W	
3	Th	
4	F	
5	S	
6	**S**	
7	M	
8	Tu	
9	W	
10	Th	
11	F	
12	S	
13	**S**	
14	M	
15	Tu	
16	W	Ordinary Meeting
17	Th	(Opening Meeting
18	F	of the Session)
19	S	
20	**S**	
21	M	Cantor Lecture I. 1
22	Tu	
23	W	Ordinary Meeting
24	Th	
25	F	
26	S	
27	**S**	
28	M	Cantor Lecture I. 2
29	Tu	
30	W	Ordinary Meeting

DECEMBER, 1892.		
1	Th	
2	F	
3	S	
4	**S**	
5	M	Cantor Lecture I. 3
6	Tu	
7	W	Ordinary Meeting
8	Th	
9	F	
10	S	
11	**S**	
12	M	Cantor Lecture I. 4
13	Tu	
14	W	Ordinary Meeting
15	Th	
16	F	
17	S	
18	**S**	
19	M	
20	Tu	
21	W	
22	Th	
23	F	
24	S	
25	**S**	Christmas Day
26	M	*Bank Holiday*
27	Tu	
28	W	
29	Th	
30	F	
31	S	

JANUARY, 1893.		
1	**S**	
2	M	
3	Tu	
4	W	Juvenile Lecture I.
5	Th	
6	F	
7	S	
8	**S**	
9	M	
10	Tu	
11	W	Juvenile Lecture II.
12	Th	
13	F	Howard Lecture 1
14	S	
15	**S**	
16	M	
17	Tu	For. & Col. Section
18	W	Ordinary Meeting
19	Th	Indian Section
20	F	Howard Lecture 2
21	S	
22	**S**	
23	M	
24	Tu	Applied Art Section
25	W	Ordinary Meeting
26	Th	
27	F	Howard Lecture 3
28	S	
29	**S**	
30	M	Cantor Lecture II. 1
31	Tu	

FEBRUARY, 1893.		
1	W	Ordinary Meeting
2	Th	
3	F	Howard Lecture 4
4	S	
5	**S**	
6	M	Cantor Lecture II. 2
7	Tu	Applied Art Section
8	W	Ordinary Meeting
9	Th	
10	F	Howard Lecture 5
11	S	
12	**S**	
13	M	Cantor Lecture II. 3
14	Tu	
15	W	Ordinary Meeting
16	Th	Indian Section
17	F	Howard Lecture 6
18	S	
19	**S**	
20	M	Cantor Lecture II. 4
21	Tu	Applied Art Section
22	W	Ordinary Meeting
23	Th	
24	F	
25	S	
26	**S**	
27	M	
28	Tu	For. & Col. Section

MARCH, 1893.		
1		
2	W	Ordinary Meeting
3	Th	
4	F	
5	S	
6	**S**	
7	M	Cantor Lecture III. 1
8	Tu	
9	W	Ordinary Meeting
10	Th	Indian Section
11	F	
12	S	
13	**S**	
14	M	Cantor Lecture III. 2
15	Tu	Applied Art Section
16	W	Ordinary Meeting
17	Th	
18	F	
19	S	
20	**S**	
21	M	Cantor Lecture III. 3
22	Tu	For. & Col. Section
23	W	Ordinary Meeting
24	Th	
25	F	
20	S	
27	**S**	
28	M	
29	Tu	
30	W	
31	Th	
	F	Good Friday

APRIL, 1893.		
1	S	
2	**S**	Easter Sunday
3	M	*Bank Holiday*
4	Tu	
5	W	
6	Th	Indian Section
7	F	
8	S	
9	**S**	
10	M	Cantor Lecture IV. 1
11	Tu	Applied Art Section
12	W	Ordinary Meeting
13	Th	
14	F	
15	S	
16	**S**	
17	M	Cantor Lecture IV. 2
18	Tu	For. & Col. Section
19	W	Ordinary Meeting
20	Th	
21	F	
22	S	
23	**S**	
24	M	Cantor Lecture IV. 3
25	Tu	
26	W	Ordinary Meeting
27	Th	Indian Section
28	F	
29	S	
30	**S**	

MAY, 1893.		
1	M	Cantor Lecture IV. 4
2	Tu	For. & Col. Section
3	W	Ordinary Meeting
4	Th	
5	F	
6	S	
7	**S**	
8	M	Cantor Lecture V. 1
9	Tu	Applied Art Section
10	W	Ordinary Meeting
11	Th	Indian Section
12	F	
13	S	
14	**S**	
15	M	Cantor Lecture V. 2
16	Tu	For. & Col. Section
17	W	Ordinary Meeting
18	Th	
19	F	
20	S	
21	**S**	Whit Sunday
22	M	*Bank Holiday*
23	Tu	
24	W	
25	Th	
26	F	
27	S	
28	**S**	
29	M	
30	Tu	
31	W	Ordinary Meeting

JUNE, 1893.		
1	Th	
2	F	
3	S	
4	**S**	
5	M	
6	Tu	
7	W	
8	Th	
9	F	
10	S	
11	**S**	
12	M	
13	Tu	
14	W	Conversazione
15	Th	
16	F	
17	S	
18	**S**	
19	M	
20	Tu	
21	W	
22	Th	
23	F	
24	S	
25	**S**	
26	M	
27	Tu	
28	W	Annual General Meeting
29	Th	
30	F	

The chair will be taken at Eight o'clock at each of the Ordinary Meetings, the Cantor Lectures, Howard Lectures, and the Meetings of the Applied Art Section.

The Meetings of the Indian Section will commence at Half-past Four o'clock.

The Meetings of the Foreign and Colonial Section will commence at either Half-past Four or Eight o'clock, as may be announced from time to time.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Seven o'clock.

Notices.

FOREIGN AND COLONIAL SECTION.

A meeting of the Committee of the Section was held on Tuesday, 15th inst. Present:—C. M. Kennedy, C.B., in the chair; Sir Edward Braddon, K.C.M.G.; Francis Cobb; C. Washington Eves, C.M.G.; Sir Douglas Galton, K.C.B., F.R.S.; Walter H. Harris; Sir Saul Samuel, K.C.M.G., C.B.; P. L. Simmonds; with Sir Henry Trueman Wood, M.A., Secretary to the Society, and Edward Cunliffe-Owen, C.M.G., Secretary to the Committee.

The programme of papers to be read during the present Session was discussed.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 16th instant. Present: Sir Richard Webster, Q.C., M.P., Chairman; Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., M.D., Sir Edward Braddon, K.C.M.G., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Michael Carteighe, R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Prof. James Dewar, M.A., F.R.S., Sir Henry Doulton, James Dredge, F. Elgar, LL.D., Prof. C. Le Neve Foster, D.Sc., F.R.S., Sir Douglas Galton, K.C.B., F.R.S., Walter H. Harris, A. B. W. Kennedy, F.R.S., C. Malcolm Kennedy, C.B., J. Fletcher Moulton, Q.C., F.R.S., John O'Connor, Prof. W. Chandler Roberts-Austen, C.B., F.R.S., Sir Owen Roberts, M.A., Sir Saul Samuel, K.C.M.G., C.B., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Monday, 14th inst. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, Lord Alfred S. Churchill, Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Sir Henry Doulton, James Dredge, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., John O'Connor, W. H. Preece, F.R.S., Sir Owen Roberts, M.A., D.C.L., F.S.A., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

FINE ARTS COMMITTEE.

A meeting of the Fine Arts Committee was held on Friday, 11th inst. Present: Sir Frederick Leighton, Bart., P.R.A., in the chair; J. Macvicar Anderson, Pres. R.I.B.A., Wyke Bayliss, Pres. R.S. Brit. Artists, F. Seymour Haden, Pres. R.S. of Painter Etchers, Sir James D. Linton, Pres. R.Inst. Painters in Water Colours, H. Stacey Marks, R.A., Deputy-President R.S.P.W.C., Walter William Ouless, R.A., Edward J. Poynter, R.A., Hamo Thornycroft, R.A., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

Proceedings of the Society.

FIRST ORDINARY MEETING.

Wednesday, Nov. 16, 1892; Sir Richard E. Webster, Q.C., M.P., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Allen, George William, C.I.E., 179, Queen's-gate, S.W.
Anderson, John, junior, Atlantic Mills, Bridgeton, Glasgow.
Ascough, Jesse, Patent Borax Co., Ledsam-street, Ladywood, Birmingham.
Ash, Henry Claudius, Ovingdean, High-road, Brondesbury, N.W.
Baker, William, 1, Chetwynd-road, Lawrence-road, Southsea.
Bantock, George Granville, M.D., F.R.C.S., 12, Granville-place, Portman-square, W.
Barclay, Sir Colville, Bart., C.M.G., 11, Rue François Ier, Paris.
Barnes, S. J., Mayfield, Moseley Wake-green, near Birmingham.
Barrett, Robert, 2, Pembroke-gardens, Kensington, W.
Beare, Prof. Thomas Hudson, University College, Gower-street, W.C.

Beeton, Henry Coppinger, 2, Adamson-road, South Hampstead, N.W.
Beevor, Septimus Felix, B.A., 25, Leinster-square, W.
Bousfield, Charles Edward, St. Mary's-mount, Leeds.
Broad, Clement Burgess, Stamford Brook-lodge, Ravenscourt-park, W.
Bruce, Benjamin John Elder, Town-hall, Hull.
Chapman, Henry Alfred, 235, High-street, Swansea.
Cheswright, Charles, The Homestead, Anson-road, N.
Chutter, George F. Buckingham-street, Birmingham.
Clemson, Walter, J., M.A., Taunton, Mass, U.S.A.
Colbron, Joseph Parkin, 2, Osborne-street, Hove, Brighton.
Constantine, Ezekiel Grayson, 32, Victoria-street, Manchester.
Crawter, Frank Whinfield, 35, St. George's-square, Regent's-park, N.W.
Cripps, Charles Alfred, Q.C., 32, Elm-park-gardens, S.W.
Crosse, Hammond William, Deodar-road, Putney, S.W.
Cunningham, Lieut.-Col. Allan J. C., 19, Palace-gardens-terrace, Kensington, W.
Davis, Henry W. B., R.A., 18, St. John's-wood-road, N.W., and Glaslyn, Rhayader, Radnorshire.
Day, Lewis Foreman, 13, Mecklenburgh-square, W.C.
De Morgan, William, 1, The Vale, Kings-road, Chelsea, S.W.
Ede, Francis Joseph, Silchar, Cachar, India.
Ellis, Herbert Moates, Inglesham, Crescent-road, Wimbledon, Surrey.
Estall, George, Lillie-bridge Works, West Brompton, S.W.
Farden, Richard S., 29, Milk-street, E.C.
Farren, George, J.P., Trefani, Carnarvon, and Reform Club, S.W.
FitzGerald, Augustus Edward, Athenæum, Manchester.
Fleming, Ernest Laremont, 11, Bold-street, Warrington.
Gooday, John Francis Sykes, 4, Furnival's-inn, E.C.
Gourlay, Henry, Clatto, Cupar, Fife.
Gray, George Godfrey, LL.D., J.P., 33, Wellington-square, Hastings, and 19, Old-square, Lincoln's-inn, W.C.
Gray, Thomas L., Rokesley-house, 23, St. Michael's-road, Stockwell, S.W.
Gross, William, B.A., 49, Upper Gloucester-place, Dorset-square, N.W.
Hamerton, George A., M.D., 3, Southampton-street, Covent-garden, W.C.
Harris, Richard, 3, Vinery villas, Regent's-park, N.W.
Harvey, Edward Arthur, 26, Victoria-square, Clifton, Bristol, and Junior Carlton Club, S.W.
Hawksley, Thomas, M.D., Beowands, Chertsey, Surrey.
Hedley, John Hunt, 55, John-street, Sunderland.
Hehir, Surgeon Captain Patrick, M.D., Hyderabad, Deccan, India.
Henderson, Alexander, 52, Princes-gate, S.W.
Hepper, John, Clareville, Headingley, Leeds.
Hodges, George H., J.P., Oadby Frith, Leicester.
Holmes, Charles, St. Helen's, Dennington-park-road, West Hampstead, N.W.
Howe, George, 41, Wigmore-street, W.
Howell, Edward, Yeovil, Somerset.
Hughes, Herbert William, Priory Farm house, Dudley.
Ingram, William James, 108, Beckenham-road, Penge, S.E.
Ives, Frederic E., Philadelphia, Pa , U.S.A.
Lamb, John Cameron, C.M.G., 4, Vanbrugh-hill, Blackheath, S.E.
Liechtenstein, His Highness John, Prince of, Feldsberg, Austria.
Lloyd, Herbert Gore, 6, West Kensington-gardens, W.
McFarlane, William, care of William Dunn and Co , 43, Broad-street Avenue, E.C., and Cedar Lea, Bournemouth.
Margary, Peter John, Tavistock Hotel, Covent-garden, W.C.
Mitchell, Joseph, J.P., Bolton-hall, near Rotherham.
Mond, Robert Ludwig, M.A., The Poplars, 20, Avenue-road, N.W.
Morris, David, Manora, Karachi, India.
Morris, James, 1, Dalal-street, Bombay, India.
Murton, Charles Augustus, 6 Vanbrugh-park-road West, Blackheath, S.E.
Newman, George, Billiter-street, E.C.
Notley, Richard A., 80, Cornhill, E.C.
O'Callaghan, Francis Langford, C.S.I., C.I.E., United Service Club, Simla, India.
Page, Major S. Flood, 102, St. George's-square, S.W.
Peter, Thurstan C., Redruth.
Pontifex, Charles, 5, Wetherby-gardens, South Kensington, S.W.
Poore, George Vivian, M.D., F.R.C.P., 30, Wimpole-street, W.
Portal, Lieut. Bertram Percy, 17th Lancers, Malshanger, Basingstoke, Hants.
Portal, Spencer John, Bere-hill, Whitchurch, Hants.
Potter, Thomas Wickford, Budby Castle, Edwinstowe, Newark.
Powell. Alfred Ernest, 478, Stockport-road, Longsight, Manchester.
Press, William James, Burnham, Somerset.
Preston, F. J., Bhusawal, Khandeish, Bombay, India.
Prigg, Henry Victor, Borough Engineer's Department, Plymouth.
Purveez, N. M., care of J. Lyon and Co., 4, Lombard-court, E.C.
Rabbits, William Thomas, 6, Cadogan-gardens, S.W.

Roberts, Emmanuel, M.D., Rakwana, Ceylon.
Robinson, Mark, Chatley, Fassett-road, Surbiton, and Picton-house, Thames Ditton, Surrey.
Sachs, Edwin O., 26, Marlborough-hill, N.W.
Shaw, Peter, 98, Church-street, Fulham-road, S.W.
Simpson, William John, M.D., 16, Theatre-road, Calcutta, India.
Smith, Henry, 8, John-street, Adelphi, W.C.
Smith, Swire, Lowfield, Keighley, Yorks.
Tanner, Slingsby, 104B, Mount-street, Berkeley-square, W.
Tarn, Arthur Windham, 55, Torbay-road, Brondesbury, N.W.
Thomas, William, Penelvan, Camborne.
Thomas, William Brodrick, 52, Wimpole-street, W.
Todd, Hugh Armstrong, 59, Weymouth-street, Portland-place, W.
Townsend, Charles, M.P., St. Mary's, Stoke Bishop, Gloucestershire.
Townsend, Edward, 14, Harold-road, N.
Valon, William A., Hardress-street, Ramsgate.
Wade, James L, 28, West Kensington-gardens, W.
Wade, Seymour, Weehawken-house, Fulham, S.W.
Walker, Charles Robert, 15, Great George-street, S.W.
Waring, Francis John, Nanu Oya, Ceylon.
West, Sir Raymond, K.C.I.E., Chesterfield College-road, Norwood, S.E.
White, John Isawoo, M.A., Township-office, Pyinmana, Upper Burma.

The CHAIRMAN delivered the following

ADDRESS.

In addressing you from this place for the third year in succession, I desire to acknowledge, with gratitude, the great compliment that has been paid me by the Council and the Members of the Society in electing me as Chairman of the Council for an additional period of two years. Beyond the earnest desire shared by all the Council to serve the Society, I feel that I have not special qualifications, and I feel that the only way in which I can properly show myself grateful for the honour paid me, is by giving to the Society, both in connection with its ordinary work, and as the Royal Commission to the Chicago Exhibition, all the time which is at my disposal from other duties; and I earnestly hope that the interests of the Society will not suffer at my hands.

The works of the Society during the last session have been so varied, that there have been many topics upon which the time at my disposal this evening might be fully occupied. An examination of the papers for the last session will show that the communications to the Society, both from the point of view of originality and comprehensive grasp of subject, were well worthy of the reputation which the Society has long enjoyed. It will be again my pleasure, at a later period of the evening, to refer to some of those papers in connection with the distribution of the medals which I am privileged to present; but I am sure that those members who have attended the ordinary meetings during the last session will agree that the advance of science and the progress of discovery were recorded in a way likely to convey most useful information, not only to those present at the time, but also to those who had the opportunity of reading the communications in the publications of the Society.

It is part of my duty to refer to the losses by death which the Society has sustained since I last addressed you. There will rise to the mind of every one the name of that distinguished Prince whose death, in the early part of this year, caused such an irreparable gap in the family of his Royal Highness our President, and spread over the whole nation, and over every part of the Empire, a gloom from which we have not yet recovered. In memory of the universal woe expressed for his loss, I need say no more except to record here publicly, and on behalf of the members, as the Council did by their resolution at the time, our deep sympathy with our gracious Queen, his Royal Highness our President, and the Princess of Wales. Two recipients of the Albert medal —Sir George Airy, Astronomer Royal, and Dr. A. W. Hofmann, the distinguished chemist —have passed away. The other scientific bodies in the scientific world in general have recorded their sense of the beneficial results of their labours, and their contributions to science; their names will long live in the memory of those who pursue the investigations in which they were so successful. I must mention, in addition, the names of Sir James Brunlees, Dr. Alfred Carpenter, Dr. Tidy, and Mr. P. W. Willans, all of whom will be well remembered for their efforts in the cause of science; and to them must be added the names of Sir James Allport, Surgeon-Major Bellew, Cyrus Field, Dr. John Forbes Watson, and the two distinguished dukes, both of whom have filled the office of Vice-President, and were members of the Society for upwards of 25 years, I mean the Duke of Devonshire and the Duke of Sutherland. Time does not permit more than a passing reference to any of those whose names I have mentioned. The members of the Society will not have forgotten the efforts of Dr. Carpenter and Dr. Tidy in connection

with sanitary science, and the attainments of the latter gentleman on the subject of legal medicine, which gained for him the award of the Swiney prize in the year 1889. One other of these names I would mention, scarcely less widely known, and that is P. W. Willans. Cut off at the early age of 40, while in the full possession of his remarkable abilities, he left a gap in the ranks of mechanical engineers which, indeed, it would be hard to fill. The extraordinary skill which he brought to bear in the development and perfecting of the Willans engine, so largely used and widely known in connection with electric lighting, convinced every one with whom he was brought in contact that he had a great future before him, while his power of organisation and grasp of labour problems rendered him in every way competent to assist and guide in connection with manufacturing works.

I have already stated that the papers which have been read during the last Session compare favourably with those of any previous year; and it is interesting to watch how, from time time, scientific thought and knowledge revert again to problems which have been thought insoluble, and to achievements which have been regarded as impossible. Some two years ago I referred to the progress made in photography, and, during the current year, the question of the representation of objects by photography in their natural colours has again been attracting a great deal of notice. At present, I cannot say that any marked advance has been made; but a very remarkable application in a kindred subject was exemplified by the very interesting paper of Mr. F. E. Ives on "Composite Heliochromy," in which he, by the most ingenious arrangement of lenses and coloured plates, reproduced to the eye the original colours of the objects photographed. It may be thought by some that there is no immediate connection between this result and the permanent production of the colours; but, it appears to me, and to others who possess a far greater knowledge of the subject than I, that it may prove a valuable step in the development of photographic science. Whilst upon this subject, I would mention two remarkable developments in connection with photography, which, although they have not at present formed the subject of communications to the Society, may, I trust, be brought to the notice of the members on some future occasion. I, refer in the first instance, to the remarkable achievements of Prof. Boys in the photographing of pistol and Martini-Henry bullets in their passage through the air. This was exhibited at the Royal Society, and I trust that Prof. Boys may be able, at a future date, to read a paper at the Society of Arts. I understand that the arrangement whereby the bullet in its passage through the air completes the contact between two terminals, thereby producing a sudden display of light, which causes the bullet to photograph itself upon the sensitive plate placed to receive its impression at the moment of the light, was designed and carried into effect by Prof. Boys's ingenuity. I hesitate to trust myself from memory to record the space of time during which the impression of the bullet was taken, but if my memory does not fail me, he had in some instances succeeded in taking an impression in $\frac{1}{4000000}$th part of a second, and in others the period of exposure was even shorter. The way in which the photographs record the distinct effect of the wave of air in front of the bullet, and the following wave of air behind, and their effect upon the surrounding atmosphere; and in another instance, the effect of the bullet striking a plate of glass, were, in my humble judgment, some of the most remarkable productions of the photographic art which have yet been devised, and open a future for that science unthought of by the most scientific men of a few years ago.

I referred, on a previous occasion, to the work of photography in connection with astronomy, and those who followed the interesting history of the discovery of the new star in Auriga will not have failed to fully appreciate the assistance rendered by photography to astronomers. The other development of this art, to which I wish to direct attention, was the interesting report that an object had been photographed at some 50 miles distance by a telescopic camera. Probably this is only an instance of what can be effected by means of improved apparatus, but, at the same time, having regard to the predictions of the early experimenters in this art, it must be regarded as a very remarkable achievement.

The subject of electricity has, as might be expected, been dealt with on more than one occasion in papers during the previous session, and I shall have the pleasure this evening of presenting a medal to Mr. Robertson for his paper on secondary batteries. The present occasion may justify one for a few moments, in looking back on the near past, and observing once more the marvellous achievements and extraordinary growth of electrical

science. Barely 15 years ago the sub-division of the electrical current was regarded as a practical impossibility. The period of a generation, during which the workers knew that which they desired to attain, and all but hit upon the means of attaining it, had proved fruitless until the greatest minds, including no less persons than Lord Kelvin and the late Sir William Siemens, not more than twenty years ago, expressed an opinion that practical distribution was all but an impossibility. What do we say to-day? Not only are many millions of electric lights burning nightly in London and in other towns in this country, and all over the world, but the power developed at great central stations is distributed and utilised for all manner of purposes, for motors, for lighting, for heating, and many kindred applications. The storage of electricity, long known and discovered by the great Plantè as a scientific fact, has become by the labours of recent years a commercial operation. It is within my own memory that but a few years the idea of utilising the power of Niagara and other great waterfalls was regarded by many best able to judge as being beyond the range of practical science, and those who, not twenty years ago, expressed their belief in such possibilities, were regarded as dreamers and mere enthusiasts. What is the position to-day? I believe that in the town of Galway, in Ireland, there has been established a public central station converting into electricity the water power that has long been running to waste in disused mills, and distributing it for all purposes, and I notice that amongst the papers which are to be read before the meetings of this Society, in the early part of this session, is one by Professor George Forbes on the utilisation of Niagara. These facts alone will cause many thinking men to pause and hesitate before they pronounce the prophecies of science as being only the dreams of enthusiasm. The history of the early efforts in connection with the discoveries of Planté, Faure, Sellon, and others have periodically formed the subject of communications to the Society, and it is not too much to say that in the records will be found a complete history of their development and improvement.

In connection with electricity, I further have great pleasure in reminding the members that our President, on the recommendation of the Council, awarded the Albert Medal for the year 1892 to that pioneer in electrical science, and that inventor who has astonished every country in the world by the versatility of his resources and the breadth of his conceptions, Thomas Alva Edison.

The series of lectures to be delivered under the Howard bequest, on the subject of the transmission of power from central stations, will afford a valuable opportunity of obtaining information upon the progress of invention in connection with this important matter.

To but one other subject must I permit myself to refer in this connection. On previous occasions I have called attention to the utilisation of silk waste by the inventions of Lord Masham and the discoveries of Mr. Wardle. The subject has been brought prominently to the attention of the Society by the valuable paper of Mr. Purdon Clarke on "English Brocades and Figured Silks," which certainly forms a very useful addition to the history of silk industry.

There is, perhaps, no subject of more practical importance to the travelling public, both on sea and land, than that of colour blindness. Mr. Brndenell Carter, a distinguished member of your Council, in his series of Cantor lectures upwards of ten years ago, directed public attention to the question, and a committee of the Royal Society has been recently appointed to investigate, and, to the best of their power, throw light upon many of the debateable questions in connection therewith. The secretary to this committee was Captain Abney; and I would commend to persons interested in the subject not only the study of his paper, but also to make themselves acquainted with the extremely ingenious apparatus devised by Mr. Brudenell Carter, and exhibited at the Royal Society by him for the purpose of practically testing the condition of eyesight in this connection.

I must now, with regret, pass from the ordinary work of the Society during the previous Session. There are many subjects to which it would have given me pleasure to refer, and on which I might, with some advantage to the members, have spoken at length, but time and the pressure of other matters will not permit. I may mention the interesting paper of Dr. Augustus Voelcker on the "Industrial Needs of India, and refer to Professor Vivian Lewes's research into the "Spontaneous Ignition of Coal, and to Professor Silvanus Thompson's valuable contribution on the subject of the "Measurement of Lenses," which forms a very suitable addition to the contributions of Mr. Beck and Mr. Dallmeyer, in the years 1889 and 1890. The paper of Captain Younghusband

upon the Pamirs is of especial interest, having regard to the important events which have recently been taking place in that region. I, on a previous occasion, drew attention to the valuable contributions to science contained in a long series of Cantor Lectures, delivered under the auspices of the Society, under the Cantor bequest. Those for the coming session promise to be no less important than their predecessors, including one from Professor Vivian Lewes on "The Generation of Light from Coal Gas," from Dr. Fleming on "The Practical Measurement of Alternating Electric Currents, and from Professor Chandler Roberts-Austen on the subject of alloys; while the Arts Section, whose interest will I trust never be overlooked by the Society, will receive contributions from Mr. Lewis Forman Day, who will deliver four lectures, entitled "Some of the Past Masters of Ornament;" and from Mr. Townsend on "The History and Practice of Mosaics."

The past year has been marked by an event upon which the members of the Society will, I am sure, feel great interest, that is the partial completion of the Imperial Institute, a work in which his Royal Highness, our President, takes, as is well known, the keenest interest, and to the growing prosperity of which Sir Frederick Abel, a distinguished member of our Council, very largely contributed. I need not say that, echoing the thought which I ventured to express when I addressed you in the year 1890, we sincerely hope that there is in store for this Institution a brilliant career, and so far as it is in the power of the Council of the Society or its members to advance the interests of the Institute, it will certainly be our duty as well as our pleasure to leave no effort unspared to that end.

The time of the Council has been very fully occupied, as may be imagined, by the work imposed upon its members in connection with the Chicago Exhibition. As I informed you, on the last occasion when I stood in this place, her Most Gracious Majesty was pleased to appoint the President, Vice-Presidents, and Council of the Society of Arts a Royal Commission to represent and take charge of the representation of Great Britain and her Colonies, at the great Exposition to be held at Chicago in the year 1893. By the kindness of gentlemen connected with that great undertaking, I am in a position to-night to put before you some very interesting pictures both of Chicago and of the Exhibition, which enables me to present the condition of matters as it stands to-day, and it is also my pleasure to inform you that on the 7th December there will be read a paper by Mr. James Dredge, member of the Council, which, supplementing as it does his paper on two previous occasions, will be of great value to the intending exhibitors and visitors to the Exhibition. Perhaps I may be permitted to say, without, offence that no member of the Council has devoted more time and attention to the concerns of the Exhibition, and that his practical knowledge, both of Chicago and of the needs of exhibitors, has been of the greatest assistance to the Council.

It is desirable that, as your Chairman, and for the information of the members, I should state, at any rate, one general outline of the present position of matters in connection with that great exhibition. It will be remembered that the sum of £25,000 was originally granted to the Society, and that it was contemplated that that should be supplemented, as at the Paris exhibition, by a payment by exhibitors for the space allotted. The attention of Parliament being, however, directed to the subject, and a general wish being expressed that the amount should be increased, and that no charge should be made to exhibitors, the Lords of the Treasury were, on the suggestion of the Council, good enough to increase the amount to the sum of £60,000. This sum, although by no means too large for the demands made on the Council, will, I trust, be sufficient to enable the Royal Commission to make proper arrangements for the interests of British exhibitors.

A site for the British offices was placed at the disposal of the Commission by the executive of the Exposition, and there are being erected offices for the British section according to the design prepared by Colonel Edis, honorary architect of the Commission, representing an old English half-timbered house. Her Most Gracious Majesty has been pleased to permit the offices to be named "Victoria House," and a photograph of the design of the building now in course of erection will be shown to you this evening. I had hoped to be able to put before you a photograph of the external appearance which the house now presents. I believe it has been roofed in, and is in a more advanced condition than the buildings of any other foreign nation; but the photograph which I expected to receive from Colonel Grover, who is superintending the erection on behalf of the Commission, has not

at present arrived. The house will be furnished by Messrs. Johnston, Norman, and Co., from designs specially prepared by Colonel Edis. The space occupied by Great Britain and the Colonies will amount to upwards of 450,000 square feet, of which upwards of 250,000 square feet will be occupied by Great Britain. This is the largest space ever filled at any international exhibition by any foreign country; and it is interesting to compare it with the space occupied by Great Britain and the Colonies in previous exhibitions—in Vienna, 170,000 square feet; Philadelphia, 195,000 square feet; Paris, 1878, 363,000 square feet; and Paris, in 1889, 233,000 square feet. Allotments have been made to us in the following buildings:—Agriculture, Forestry, Live Stock, Fisheries, Mines and Mining Machinery, Transportation, Manufactures and Liberal Arts, Electricity, Fine Arts, and the Women's Building.

It would not be possible for me to give you anything like a full or exhaustive description of the nature of the exhibits in each of these buildings, but the Commission are satisfied that in the great majority, if not in all, the industries of Great Britain will be fully represented. In the Manufactures Building will be found amongst others the producers of ornamental china and glass, among whom will be Messrs. Doulton and Co., the Worcester Royal Porcelain Company, the Coalport Glass Company, Brown, Westhead, Moore, and Co., and many others. Amongst the exhibitors of furniture are many of our leading firms; and, in the textile fabrics, a very important exhibit from the Irish linen manufacturers. In jewellery I believe there will be a unique collection of reproductions of old Irish gold work by Mr. Edward Johnston, as well as a fine collection by the Goldsmiths' and Silversmiths' Company. In chemical products, Great Britain will be well represented.

In the galleries of Manufactures and Liberal Arts Building—in which a considerable space has recently been placed at the disposal of the Commission—will be found a loan collection of photographs, containing contributions from the leading British photographers, both professional and amateur.

There will be also an extremely interesting collection of ancient newspapers prepared by Mr. Sell, and educational appliances by the School Board for London, and the Science and Art Department. Many of our principal makers of scientific instruments will also exhibit. Another most important exhibit will be in the Transportation Gallery, many of our great railway companies being well represented, the London and North-Western sending an engine and train, the Great Western a broad gauge engine, the Great Eastern, Midland, and Irish railways also exhibiting, in addition to other private manufacturers. There will be a very large collection of cycles, contributed by nearly all the leading makers, in which industry it is well known that Great Britain practically holds command. In the models of ships, the great majority of our leading companies, the Cunard, White Star, Union Steam Ship, Donald Currie, and, in addition, Sir William Armstrong, Mitchell and Co., the Fairfield Ship Building Company, Laird Brothers, J. and G. Thompson, the Thames Ironworks Company, John Brown and Company, and Dennys of Dumbarton, will be represented.

In the Machinery Building, exhibits are not as numerous as the Council could have wished, but the great firm of Platt Brothers, of Oldham, are sending an important exhibit, and there will also be exhibits by other makers of looms, spinning frames, printing machinery, and steam hammers. In the Agricultural Section, so far as agricultural machinery is concerned, Great Britain, as might be expected by those acquainted with the industry, will not be largely represented; but in the Food Department, which forms part of this section, there will be many most important exhibitors; the London and Provincial Dairy Company will, in connection with this department, have a model of a working dairy as a separate exhibit located in the grounds, and there will be a fine exhibit of baking machinery also in a separate building. Mr. Burdett Coutts, M.P., is sending a fine model of his stud farm. The White Star Company will have a kiosk in the grounds, illustrating the arrangements of their ships, and a *fac-simile* model of Shakespeare's house, at Stratford-on-Avon, will be exhibited by the *Illustrated London News*.

The Council regret that, in the Electricity Building, the exhibitors from Great Britain will not be numerous, but there will be a very fine collection of telegraphic apparatus lent by the British Post-office. In the building for mines and mining there will be sections illustrating English mineralogy and metallurgy, and a very fine exhibit of platinum and other rare metals, by Messrs. Johnson and Matthey. In the department of the Fine Arts the Council are in hopes that the exhibit will be in every way worthy of the nation. The

Fine Art Committee, which has special charge of this section, has been presided over by Sir Frederick Leighton, the President of the Royal Academy, who has given the greatest attention to the matter, and endeavoured, to the utmost of his power, to obtain a representative exhibit. Very few, if any, of our prominent living artists will be unrepresented, and the list of exhibitors already includes the great majority of the names best known to the frequenters of our galleries. I hope, however, that I may still appeal to the members of the Society, and through them to others—the owners of representative works of British artists to permit them to be exhibited, as the Council consider it to be of the greatest importance to the cause of British art that there should be on this occasion a thoroughly representative display.

In the Fishery Building there will be a typical collection of fishing gear and exhibits of anglers' requisites. In the Horticultural Department, in consequence of the length of transit, there will not be so many exhibits of British horticulture as the Council could have desired.

I have given this brief summary of the results of the work of the Commission, not so much with a view to informing you and the public of that which is already known, as of bearing testimony, on behalf of the Council, to their appreciation of the way in which the appeal made last year has been responded to. I then pressed, as earnestly as lay in my power, on the attention of the Society the extreme importance of Great Britain being well represented. To that appeal the Council feel that the response has indeed been generously made, and that, through the agency and instrumentality of this Society, much has been done to render the British Section of the great Exhibition of Chicago worthy of the nation. But I must not pass from this part of my subject without expressing, on behalf of the Council, and on your behalf, to the Ladies' Committee our appreciation of their efforts on behalf of women's work. The Committee of Ladies, presided over by H.R.H. Princess Christian, assisted by many other ladies of position and experience, has been successfully engaged in endeavouring to secure the best exhibits, in order to illustrate women's work and improve the condition of women.

Mrs. Bedford Fenwick, deputed by the Ladies' Committee to visit the United States, has recently returned, and, from the reports which she has brought, I have every reason to believe that, so far as Great Britain is concerned, the work of the Ladies Committee has proved to have have been as efficiently performed, and as useful as that of any committee which has sat under the auspices of this commission.

Amongst the British colonies, Canada will be the largest exhibitor, as might naturally be expected, occupying between 60,000 and 70,000 feet. She has large exhibits in agriculture and mining, as well as in manufactures, and a separate special building is being erected in the grounds for the offices of the Canada Commission. The colony of New South Wales will be well represented, as also the Cape, which exhibits, amongst other things, a magnificent collection of diamonds. Ceylon will have one or more tea houses in the grounds of the Exhibition, for the sale of Ceylon tea. As regards India, while I deeply regret that the Government of India did not see their way to assist actively the Exhibition, the tea planters will be well represented, and there will also be a collection of Indian art.

Other Colonies represented include Jamaica, British Guiana, the Mauritius, Trinidad, British Honduras, Barbadoes, and the Windward and Leeward Islands. In every building the British Colonies are located in close proximity to the mother country.

I have already informed you that I am in a position to show you the photographs of some of the principal buildings now already erected at Chicago, and it will be interesting, to compare, in addition, many features of this Exhibition with those held on previous occasions. The total area of grounds at Chicago will be 633 acres, being more than double that of Paris in the year 1889, and the Centennial Exhibition in Philadelphia in 1876. The buildings will occupy 142 acres, as compared with 75 acres at Paris, and 70 at Philadelphia. The cost of the buildings amounts to no less than £1,457,000 sterling, as compared with £720,000 at Paris, and £1,138,000 at Philadelphia. The approximate space at Philadelphia for actual exhibits was 4,324,000 square feet, whereas at Chicago it will be 9,139,000 square feet. Some persons may be appalled by the magnitude of these figures; but it must be remembered that the details of each department need only be studied by those interested in the industries therein displayed, and certainly the arrangement of the buildings, with their adjacent canals, gardens, and water-spaces, promises to form one of the most beautiful combinations that the world has ever seen. Colonel Sadler,

reporting to Lord Rosebery upon the prospects of the Exhibition in the month of September last, states that the enormous demand for space being many times greater than the buildings can furnish, demonstrates the enthusiasm which exists, not only in America, but in almost every foreign country, with regard to the Exhibition.

In the same report Colonel Sadler expresses the belief that the Chicago Exhibition will be by far the most extensive and important that has yet taken place; that its effect on the avenues of trade will probably be wide and far spreading; and that, however greatly it may benefit many manufacturing and commercial enterprises in the United States, it offers the best possible opportunity, by means of exhibits, of making known the productions of the manufacturers of other countries.

I regret that, owing to unavoidable causes, it is not possible for Mr. McCormick to be present to-night, and, in addition, that he is unfortunately unable to continue as the representative of the Chicago Executive in London. I wish, on behalf of the Council, publicly to express the great obligations which we are under to Mr. McCormick for his unvarying courtesy and consideration, for the valuable information which he has, from time to time, afforded us, and for the assistance which he has given us, in dealing with questions of difficulty which have from time to time arisen.

Though I am not able to make a full or complete statement upon the subject, I have received from Colonel Davis, the Director-General of the Exposition, and from the four societies of Civil, Mechanical, Mining and Electrical Engineers in America, very gratifying assurances that any member of the Society of Arts visiting Chicago will not only receive a most cordial welcome, but that the rooms and conveniences of many institutions will be placed at his disposal, and further, that a committee of members of the Society of Arts resident in the United States is being formed under the presidency of Mr. E. L. Corthell, a very distinguished civil engineer; and I think I may say that if any members of the Society intending to visit Chicago will be good enough to communicate with Sir Henry Trueman Wood, there will be no doubt that they will receive every consideration and courtesy from all the members of the scientific societies in that city.

In the year 1860, Mr. Hawes, a Vice-President of this Society, and at one time Chairman of the Council, reading a most valuable paper on an occasion on which his Royal Highness the late Prince Consort was in the chair, pointed out that the object of International Exhibitions was not to amuse the idle, but to teach the industrious; not to instruct classes, but to educate nations; and to show to all the part taken by each in the labour market of the world; and Sir Thomas Phillips, Chairman of the Council, referring in the year 1861 to the same subject, pointed out that the recognition by the Crown of the functions which had been discharged by the Society of Arts in relation to International Exhibitions imposed on the Council the duty of extending their usefulness, and recording their progress, as agencies of much importance in the encouragement of Arts, Manufactures, and Commerce, and urged that advantage should be taken of any suitable opportunity to strengthen the links by which this Society is connected with International Exhibitions, so as to render the promotion of their periodical occurrence one of the recognised objects of the Society.

You know that I am not able to bring before you in detail the results of the latest investigation in any special branch of scientific research, and I have only been able briefly to remind you that this Society, both in connection with its ordinary branch, and in connection with its new position as the Royal Commission for the Chicago Exhibition, has been doing very good and useful work, not only to the scientific world, but for the public at large. But a few observations occur to me with which I will now conclude my address. A great man, years and years ago, reminded us that "The sovereignty of man lieth hid in knowledge wherein many things are reserved which kings with their treasure cannot buy nor with their force command." And, again, he said that knowledge "is a rich storehouse for the glory of the Creator and the relief of man's estate." The pursuit and acquisition of knowledge brings to the seekers and learners more and more the conviction how little we know, how puny and limited are the highest attainments of human science, compared with the immeasurable wisdom of the Creator of the Infinite.

Still, there are ever before us growing and increasing in numbers, changing with the rapidity of the kaleidoscope, ever varying in their importance and aspect, questions upon which it is the duty of every earnest thinker and worker to bring to bear all the abilities which God has given him, and if in pursuit of knowledge for itself, and for himself by the

culture of his own mind, a man or woman is able to enrich the storehouse available for others, and to establish a new starting-point from which future workers may take departure, that achievement, when rightly regarded, more than repays the worker for all his labour and anxiety. There are before us many questions upon which the members of this Society may worthily and with advantage to themselves and others devote their keenest attention; to attempt to catalogue them were idle; each succeeding year will develop fresh problems; but surely the great questions of the improved sanitary condition of our vast and increasing population, the improved water supply to our great towns, the safety of travellers by sea and land, the production of labour-saving machinery, the progress and improvement of our agriculture, and the development of fresh markets for our commerce, are subjects to which the earnest student may well direct his attention.

Ladies and Gentlemen, members of the Society of Arts, in years gone by the ranks of the Council of this Society have been filled by men of great attainments and great knowledge, who devoted no small portion of their time to the benefit of mankind and to the improvement of the reputation of this Society. You, the younger members, know that from your ranks the Council must in future years be recruited, and I appeal to those who hear me, and, I trust, I may appeal to a larger number who may think fit to read what I have said in the *Journal* of the Society — I appeal to them all to endeavour, in future years, to forward the interests of the Society—to benefit themselves — to enlarge their own knowledge—to widen the scope of their own powers, both of creation and of imagination, and so by their membership of the Society, and by the result of their efforts and attainments, to reflect credit upon their race, and to add to the immeasurable advantages which the human race has received by the labours of devoted scientific men in the past.

A series of photographs of Chicago and of the Exhibition buildings were shown on the screen. The Secretary also read a report from Mr. A. Carpmael relating to the Dedication Ceremonies, which will be found on page 19.

The CHAIRMAN said:—I have now to present to the recipients the Society's Silver Medals awarded during the past Session.

At the Ordinary Meetings:—

To Prof. SILVANUS P. THOMPSON, F.R.S., for his paper on "Measurement of Lenses."

In previous years tribute has frequently been paid to the valuable services rendered to the Society by Professor Silvanus P. Thompson. His course of Juvenile Lectures, and several courses of Cantor Lectures, are among the most valuable contributions to the literature of the Society, and he has, on several previous occasions, read most valuable papers at the ordinary meetings, the last being in the year 1889, a most exhaustive treatise on "Arc Lamps and their Mechanism." To-night I have the pleasure of awarding him a medal for his paper on "The Measurement of Lenses," which will well repay perusal.

To G. H. ROBERTSON, F.C.S., for his paper on "Secondary Batteries."

To the paper of Mr. G. H. Robertson I have already referred. Its merit consisted to a great extent in that it contained the results of original research and personal investigation into the construction and working of secondary batteries, which have so rapidly come before the notice of the public during the last ten years, and in which so much has been learnt during that period, and so many of the earlier ideas connected therewith completely exploded.

To Captain F. E. YOUNGHUSBAND, for his paper on "The Pamirs."

The paper read by Captain F. E. Younghusband, in respect to which I am privileged to present him with the Society's Medal, was especially valuable, not only on the ground of the growing importance of the district, to which I have already called attention, but to the fact that the observations therein recorded respecting the country and its inhabitants were made by him when in command of the Government expedition, and therefore are entitled to the greater weight.

To Prof. VIVIAN B. LEWES, for his paper on "Spontaneous Ingnition of Coal, and its Prevention."

In Professor Vivian Lewes we have another gentleman who, both from his qualifications and scientific attainments, and for the services he has rendered to this Society by the delivery of juvenile, popular, and Cantor lectures, well deserves recognition at your hands, and he would, I am sure, be the first to admit the debt which he owes to his connection with the Society of Arts. His paper on the "Spon-

taneous Ignition of Coal and its Prevention," is of special importance, having regard to recent occurrences.

To ROBERT S. MCCORMICK, for his paper on "The Trade Relations of Great Britain and the United States."

I have already ventured to refer to Mr. McCormick, and the feeling of gratitude entertained to him by the Council of the Society. I regret that he is unable to be present, but I am quite sure that Mr. Dredge, who receives his medal for him, will convey to him personally the expression of your gratitude and regard.

To Captain W. DE W. ABNEY, C.B., F.R.S., for his paper on "Colour Blindness."

In Captain Abney we have one who has been long connected with the Science and Art Department, and who, from his position in connection with the Committee of the Royal Society on Colour Blindness, was able to lay before the Society special researches of great value in connection with the subject of his paper. I may remind my hearers that in this or any country there exists no greater authority on the subject of photography than Captain Abney.

To F. E. IVES, for his paper on "Composite Heliochromy."

I regret that Mr. Ives is not in England to receive his medal, but inasmuch as he was only on a visit from the United States at the time that he delivered his most interesting paper, we could not expect his attendance to-night. To that paper I have already referred, and it is only necessary to add that his apparatus is the result of careful scientific labour in photography, and that in addition he has produced a very successful process of photo-typographic printing.

In the Foreign and Colonial Section :—

To F. A. PEZET, for his paper on "Peru: its Commerce and Resources."

Mr. Pezet fills the important position of Consul-General for Peru in England, and the Society are much indebted to him for the valuable information contained in his paper, with respect to which I have the honour to present him with a medal.

To Sir EDWARD BRADDON, K.C.M.G., for his paper on "Australasia: its Progress and Resources."

It was my pleasure from this place at the opening of last Session to present Sir Edward Braddon with a medal in connection with his communication to the Society on the then recent development of Tasmanian industries. During this Session he has added to our obligations to him by contributing a most interesting paper on "Australasia: its Progress and Resources," and it must be a matter of congratulation to the members of the Society that we now have the advantage of his services as a member of the Council, especially when it is remembered that he was closely connected with the Exhibition recently brought to a successful issue in Tasmania.

In the Indian Section :—

To G. H. M. BATTEN, for his paper on "The Opium Question."

In the Indian Section, the first name I have to bring to your notice is that of Mr. George Batten. It would occupy considerable time if I were to attempt to record all the services rendered to the Government of India by Mr. Batten. He has repeatedly received the thanks of Viceroys and of the Government for services rendered in many high official positions. To me personally, as an old Carthusian, it is a great gratification to know that the last time Mr. Batten received a medal was in the year 1849, was at Charterhouse, for proficiency in mathematics ; and I hope he will not the less value the one presented to him to-night, on the ground that an old Carthusian has the privilege, on behalf of the Society, of tendering to him the thanks of its members.

To Dr. J. AUGUSTUS VOELCKER, for his paper on "The Agricultural Needs of India."

The name of the next recipient, Dr. Augustus Voelcker, will bring back to the minds of many of my hearers the fact that he is the son of the distinguished chemist who for so many years fulfilled with great credit the position of chemist to the Royal Agricultural Society, in which office he was succeeded by the writer of the paper to which I am now referring. Dr. Augustus Voelcker visited India specially as the Government Commissioner to report on the agricultural conditions of that country, and his paper was communicated to the Society by the special permission of the India-office.

To JERVOISE ATHELSTANE BAINES, for his paper on "The Administration of the Imperial Census of 1891 in India."

The last medal in connection with the Indian section is to be given to Mr. J. A. Baines, of Rugby and Trinity College, Cambridge, who, since the year 1870, has been

connected with the Indian Civil Service, and in 1880 assisted in the important census operations carried on in Bombay, and is now Chief Census Commissioner for India.

In the Applied Art Section :—

To WILLIAM MORRIS, M.A., for his paper on "The Woodcuts of Gothic Books."

In the Applied Art Section I have the pleasure to award a medal to Mr. William Morris, whose absence to-night I regret. It was said of Salvator Rosa, that he was painter, poet, and musician. Mr. Morris has attained distinction in the attainments of poetry, art, and printing, but I am sure we should all agree that the world of domestic art is much indebted to him for the results of his labours, and that in the particular subject of the paper in respect of which this medal is given, he has thrown a new and clear light on an important subject in the history of art.

To C. PURDON CLARKE, C.I.E., for his paper on "English Brocades and Figured Silks."

In Mr. Purdon Clarke we have one who has long been connected with the important National Museum at South Kensington, and who has, on various occasions, read before this Society valuable papers, one of which, in the year 1884, on "Street Architecture in India," gained a Silver Medal. He has always shown the greatest interest in the work of the Committee of the Applied Art Section of the Society, and is, therefore, specially entitled to the thanks of the members.

To WILLIAM DE MORGAN, for his paper on "Lustre Ware."

It has frequently been observed in connection with more than one branch of artistic work that the secrets both of colour and finish have from time to time disappeared. From the paper read by Mr. de Morgan on lustre ware there is every reason to believe that he has re-discovered, if not entirely, yet at any rate in great part, some of the processes which in former generations produced articles of so much beauty and value.

I cannot close this list on this presentation without publicly stating that to Mr. Dredge, a Member of the Council, a Medal would certainly have been awarded for his paper on the Columbian Exposition at Chicago, but that his position as a member prevented our being able to award him that acknowledgment. He will, however, I am sure, receive the thanks of those present.

Sir FREDERICK BRAMWELL, Bart., said he now proposed to do that which was quite unnecessary, but which he was sure the meeting would not be satisfied if it were left undone, viz., to propose a hearty vote of thanks to Sir Richard Webster, not only for the address he had delivered, but for his conduct of the affairs of the Society during the past year, and by anticipation for his conduct during the year on which they had entered. He regretted, notwithstanding the interesting exhibition of photographs and distribution of medals, that he had not the opportunity of proposing this vote of thanks immediately on the conclusion of the Chairman's address, for everyone must then have been feeling most thoroughly the earnestness and value of the sentences with which that address concluded. The address itself was most difficult for anyone to deliver, because it dealt not only with the ordinary work of the Society, which was quite sufficient to tax the ability of most persons, but it dealt also with the peculiar and interesting work which the Society was now carrying on as the Royal Commission for the Chicago Exhibition. In the course of a little under an hour the Chairman had given a review of the past, a statement of what was taking place at Chicago, and evidence of that which was about to happen in connection with the English section of the Exhibition. It was a fortunate thing for the Society that at the very time when it was necessary that there should be a Royal Commission for the Exhibition, and when these duties were confided to the Society of Arts, they should have had as Chairman of the Council Sir Richard Webster, and that he should have been willing, as he had been, under the strong pressure of the members, to continue the laborious duties of the office up to the present time, and, as they all trusted, that he would continue them until the Chicago Exhibition was an accomplished fact. He begged, therefore, to move the heartiest vote of thanks to him for his conduct in the chair during the past year, and for the address he had now delivered.

Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., in seconding the motion, said it was a great honour to the Society to have such an able man in the chair. It had much to congratulate itself upon in that on this special occasion the chair of the Council was filled by a statesman such as Sir Richard Webster, who was not only an honour to the bar, but also an honour to his country, and one whose name was well known not only in America, but wherever the English language was spoken.

The vote having been put by Sir FREDERICK BRAMWELL, and carried unanimously,

Sir RICHARD WEBSTER said he was greatly touched by the exceedingly kind remarks of his old friends, Sir Frederick Bramwell and Sir Philip

Cunliffe-Owen. He had often felt that, though from a business point of view he might be able to assist the Society, he did not possess the particular qualifications which should appertain to a Chairman of the Council; but he did trust that all the members would understand and believe that he would do his utmost to maintain the reputation of that ancient and honourable Society, and that he would, as far as possible, endeavour that neither its reputation nor future success should suffer so long as he was permitted to preside over its councils.

CHICAGO EXHIBITION.

DEDICATORY CEREMONIES.

The following despatches, from Mr. Michael H. Herbert and Colonel F. Hayes Sadler, have been received from the Foreign-office :—

No. 299.
Commercial.

To the Earl of Rosebery, &c., &c.

MY LORD,—I have the honour to inform your Lordship that in accordance with the instructions contained in your Lordship's despatch, No. 88 Commercial, of the 8th instant, I left for Chicago on the 18th instant, accompanied by Mr. Peel, 3rd Secretary in this Legation, in order to attend the Dedication Ceremonies of the Chicago Exhibition.

The order of the ceremonies was as follows :—

On the 19th there was an official ball to which about five thousand persons were invited.

On the 20th there was a monster parade, through the principal streets of Chicago, of the local associations and organisations.

On the 21st there was a review of 13,000 troops in the morning, and in the afternoon the dedicatory ceremonies took place in the Manufactures Building of the Exhibition—a vast edifice which covers about 30½ acres of ground, and in which about 125,000 people were congregated. The proceedings consisted of prayers by the Episcopal and Roman Catholic dignitaries who were present ; speeches by the Vice-President of the United States, who dedicated the buildings, the President of the Exhibition, and Mayor of Chicago; and orations by Mr. Chauncy Depew and Mr. Henry Watterson.

The ceremonies throughout were of a most imposing nature, and it is impossible to speak too highly of the admirable manner in which they were organised and carried out.

I desire, at the same time, to express my high appreciation of the courtesy and kindness with which the Foreign Representatives were treated by the Reception Committee of the Exhibition.

The entire expenses of the Diplomatic Corps during their stay in Chicago were defrayed by the authorities of the Exhibition, as well as their journey to and from that city.

I have the honour to enclose a pamphlet describing the various buildings of the Exhibition, which are on a very large scale, and in every respect worthy of the most enterprising city in the United States.

I have the honour to be, with the highest respect,

My Lord,

Your Lordship's most obedient
humble servant,

MICHAEL H. HERBERT.

[COPY.]

British Consulate,
Chicago, October 24th, 1892.

No. 16.
Commercial.

To the Earl of Rosebery, &c., &c.

MY LORD,—I have the honour to report that the inauguration of the World's Columbian Exposition was celebrated last week, and that the buildings were formally dedicated by the President of the United States on Friday, the 31st instant, the buildings having been tendered on behalf of the World's Columbian Exposition by the President thereof to the President of the World's Columbian Commission, and by him presented to the President of the United States for dedication.

The ceremonies, which lasted three days and were most successfully carried out, were attended by the Vice-President, in the absence of the President, of the United States, and by a large number of invited guests from Washington, the differerent States of the Union, and foreign countries, amongst whom were the Diplomatic Corps, the members of the Supreme Court, the Ex-Presidents, the Senate and House of Representatives, the Army and Navy, the Governors of the States and Territories, the Commissioners of Foreign Governments, Consuls from Foreign Governments, and the Directors, Managers, Department Chiefs, and other officers of the World's Columbian Exposition.

Her Majesty's Government was represented by the Hon. Michael H. Herbert, Her Majesty's Chargé d'Affaires, Washington, accompanied by Mr. Arthur R. Peel. The Royal Commissioners were represented by Mr. Alfred Carpmael, Mr. J. B. Martin, and Colonel G. E. Grover, R.E. The Deputy Minister of Marine from Ottawa, the World's Fair Commissioner for Canada, and the Commissioner for Jamaica were also present.

On the 19th instant an inaugural ball, to which nearly 5,000 people were invited, was given to the guests at the Auditorium by citizens of Chicago, and was a very brilliant reception. On the 20th instant a civic procession marched through the city, which was most elaborately decorated for the occasion, and was reviewed by the President of the United States, the various associations and organisations of which

the parade was composed numbering about 60,000 persons.

On the 21st instant, the day of the final dedication, the procession was formed at 9 o'clock, a line of over 400 two-horse carriages conveying the guests, and proceeded, escorted by troops, to Washington-park, where a review of United States took place, and thence to Jackson-park, a total distance of nine miles, where the buildings were formally dedicated by the President of the United States, in the presence of the guests and about 130,000 persons, who were invited to assist at the exercises, and were assembled in the Manufactures Building.

Several addresses were made by distinguished persons, the orchestra numbered over 500 performers, and the chorus was represented by 5,70c voices.

I have the honour to enclose some extracts from the *Chicago Tribune* of the 22nd instant, giving an account of the final ceremonies.

The buildings of the Exhibition being practically complete, there now remain six months in which to decorate and fill the various buildings with exhibits, which will come from all parts of the world, before they will be open to the public on the 1st May, 1893.

I have, &c.,

(Signed) F. HAYES SADLER.

The following report has been received from Mr. Alfred Carpmael:—

Society of Arts,
John-street, Adelphi,
15th November, 1892.

DEAR SIR HENRY WOOD,—I suppose it is desirable that I should report, for the information of the Royal Commissioners, the part I have taken in the recent Dedicatory Services at Chicago.

I first called on the Honorable Michael Herbert, Chargé d'Affaires at the British Legation at Washington. He informed me that he would probably represent the British Government at Chicago, and stated his desire to afford to the Royal Commissioners every assistance in his power—an assurance which he repeated on other occasions.

On my arrival at Chicago, Mr. Fearn, the official head of all foreign matters connected with the Exhibition, called upon me. Later in the day, Colonel Grover accompanied me to Mr. Fearn's office, when the latter called, with us, on Colonel Davis, the Director-General and Master of all the Ceremonies, and other official persons.

The greater part of the following day was devoted to the inspection of the Exhibition ground and buildings — a large part of our attention being naturally given to the "Victoria House." This is a very satisfactory building, although small when compared with some of the Exhibition buildings. I suppose from 20 to 30 such buildings could be placed on the floor of the Manufactures Hall, and still leave room for streets and approaches, but, nevertheless, it compares favourably with the official buildings of other foreign countries and of the separate States, with which alone it ought properly to be compared. I observe that it has been favourably commented on in the Chicago newspapers.

The ceremonies began on the evening of the 19th October, with a ball at the "Auditorium" Hotel. Mr. Martin arrived just in time, and was present at this ball, which was attended by Mr. Morton (the acting President), and numerous persons of distinction, from all parts of the United States.

You are aware of the melancholy cause of the absence of Mr. Harrison, who was detained at Washington.

The ball was given by the City of Chicago. The invitations were limited to 3,000, and it was intended to be and was a grand reception given to foreign Commissioners and others connected with the "World's Fair."

On the following day there was a civil procession, but this, I think, was connected more with the Columbus celebration than with the Exhibition.

In the evening a dinner was given by the Fellowship Club. This club exists for the purpose of entertaining strangers, and performs some of the functions of our own Lord Mayor and Corporation. At this dinner about 50 members of the club were present, and some 150 guests. The latter included Vice-President Morton, ex-President Hayes, the Lord Chief Justice, and some others of the Judges of the Supreme Court of the United States. Cardinal Gibbons and two other Archbishops, some of the most distinguished orators of America, the Governors of 11 or 12 different States, Mr. Lincoln, Minister of the United States to this country, and Commissioners and others representing directly or indirectly almost every, if not every, country in the world. The reception given us was most cordial.

But the great ceremony of all was that of dedicating the building to the nation. This took place on Friday, the 21st October. The weather, a matter of some importance, was perfect, bright warm sunshine with blue sky without a cloud, and not even a sign of mist upon the lake. Mr. Martin, Colonel Ward (the Commissioner from Jamaica), Colonel Grover, and myself, had received an intimation that a carriage would be waiting for us at 8.45 a.m., at the point named in Michigan-avenue. We easily found our carriage, but the procession of which we were to form a part did not move till about 10 o'clock, but thenceforward we proceeded without interruption of any kind along the seven miles of Michigan-avenue (which, as you are aware, contains some of the finest residences in or near Chicago) to Washington-park, where a review of troops took place. On the conclusion of this the carriages proceeded to the Manufactures Building, where the various authorities, Commissioners, and others, were conducted to seats appropriated to them.

The building covers more than 32 acres. The whole of this great space was filled with persons who were assisting at the ceremony; their number was variously estimated from 120,000 to 160,000. Such a sight as upwards of 100,000 people assembled on one floor under one roof, had I suppose never been seen before. It quite defies description.

The making over of the buildings to the people in presence, and with the applause of such a vast multitude, had a grand and inspiring effect. When the dedication was over we were driven back to Chicago, and the spectators and others dispersed as easily and as they had been got together. This result must have required great forethought and power of organisation on the part of the authorities.

On the following day I wrote to Colonel Davis, the Director-General of the Ceremonies, expressing admiration at the completeness of the arrangements, and the wonderful manner in which the Dedication services were so successfully carried out. I have since heard from Colonel Grover that Colonel Davis was pleased to receive this letter.

As to my first impressions of Chicago, I would say that, like Washington of some years ago, it may be described as a city of magnificent distances. The buildings that first catch the eye are gigantic structures 17, 18, and even 22 stories high, nearly twice as high as any that we have in London, but besides these, which are somewhat far apart, there are fine streets, with shops that display costly wares of all sorts, though at prices that are startling, and (in addition to those already mentioned on Michigan-avenue) there are in many directions, well designed, well-built residences of the highest class; also a number of first-rate hotels, which, speaking from my short experience, are no dearer than those in other parts of America.

No one can fail to be favourably impressed by the magnitude and character of the Exhibition buildings; and, with regard to the Exhibition, I am certain that it is the intention of the Chicagoans to make their "World's Fair" one that shall compare favourably with everything of the kind that has gone before, or that may come after. No trouble, no time, and no expense will be spared, and no obstacle that can be removed by human energy will be allowed in any way to interfere with the object they have in view.

I shall always have a pleasing recollection of Chicago and the Dedication ceremonies.

I know that my hosts would have liked to have seen Great Britain represented by a Commissioner or Commissioners of rank, but all that was expressed was regret that more in number of the Commissioners were not able to be present, and a hope that all of them would attend during the coming year, an invitation which is not mere words, but is intended to be taken literally.

It only remains for me to add that I found the relations between Colonel Grover and the authorities to be of the most cordial description; it was a great pleasure to be associated with him; he is an able, courteous, and I believe thoroughly efficient representative of the Royal Commission.

The only regret that I have is, that I did not know at an earlier period that Mr. Martin would be present, as I should have liked that our call on the authorities, inspection of the buildings, &c., should have been made jointly, whereas, as it happened, his engagements and mine made any such joint action impossible.

I am, dear Sir Henry Wood,

Yours truly,

ALFRED CARPMAEL.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "The Generation of Light from Coal Gas." (Lecture I.)

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Henry Power, "Respiration in Man and Animals."

TUESDAY, Nov. 22...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on following papers:— 1. Hon. R. C. Parsons, "Halifax Graving-Dock, Nova Scotia." 2. Mr. E. W. Young, "Cockatoo Island Graving-Dock, New South Wales." 3. Mr. W. Redfern Kelly, "The Alexandra Graving-Dock, Belfast." 4. Mr. Robert Pickwell, "Construction of a Concrete Graving Dock at Newport, Monmouthshire."

Photographic, 50, Great Russell-street, W.C., 8 p.m. "The Preparation of Photographs for Exhibition, and a Demonstration of Flashlight Portraiture on Dry Ferrotype Plates."

WEDNESDAY, Nov. 23...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. Seymour Haden, "Cremation as an Incentive to Crime."

Geological, Burlington-house, W., 8 p.m. 1. Prof. Edward Hull, "Outline of the Geological Features of Arabia Petræa and Palestine." 2. Mr. J. H. Cooke, "The Marls and Clays of the Maltese Islands." 3. Rev. A. Irving, "The Base of the Keuper Formation in Devon."

THURSDAY, Nov. 24...Antiquaries, Burlington-house, 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Theodore Bent, "The Ruined Cities of Mashonaland."

FRIDAY, Nov. 25...Physical, Science Schools, South Kensington, S.W., 5 p.m. Messrs. E. C. Rimington and E. Wythe Smith, "Experiments in Electric and Magnetic Fields—Constant and Varying."

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,088. Vol. XLI.

FRIDAY, NOVEMBER 25, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 21st inst., Professor Vivian Lewes delivered the first lecture of his course on the "Generation of Light from Coal Gas."

The lectures will be printed in the *Journal* during the Christmas recess.

Chicago Exhibition, 1893.

ELECTRICITY COMMITTEE.

A meeting of the Committee on Electricity was held on Friday, 17th inst. Present: Professor W. E. Ayrton, F.R.S., in the chair; R. E. B. Crompton, Professor D. E. Hughes, F.R.S., James Paxman, W. H. Preece, F.R.S., Mark Robinson, Alexander Siemens, Silvanus P. Thompson, F.R.S., Major-General Webber, C.B., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

Proceedings of the Society.

SECOND ORDINARY MEETING.

Wednesday, November 23, 1892; George Vivian Poore, M.D., F.R.C.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Barlow, H. Dudley, care of Messrs. J. and P. Coats and Co., Paisley, N.B.

Benson, Walter, Stoneleigh, St. George's-avenue, Weybridge, Surrey.

Edwards, Stanley, 24, Fenchurch-street, E.C., and Kidbrook-lodge, Blackheath, S.E.

Parker, Hon. Cecil Thomas, The Paddocks, Eccleston, Chester.

Thompson, Bernard H., Royal Engineers'-office, Windsor.

White, William, 58, Bread-street, E.C.

Young, Robert G., The County Asylum, Colney-hatch, N.

The paper read was—

CREMATION AS AN INCENTIVE TO CRIME.

By F. Seymour Haden, F.R.C.S.

The object of the present paper is:—

I. To contrast burial as it is with burial as it ought to be; and, again, burial as it ought to be, with cremation as a proposed substitute for it.

II. To test the validity of a statement made by Sir Henry Thompson at the late Congress of Hygiene and Demography, to the effect that "Burial, by spreading infection, is a cause of increase in the zymotic death-rate."

III. To prove that, as the practice of cremation would render the clearing up of any doubts which might subsequently arise as to the cause of death in any given case impossible, such a practice cannot fail to operate as a direct incentive to crime, especially to murder by poisons known by the criminal to be difficult of detection without prolonged, and possibly repeated, methods of investigation.

Before attempting to deal with these several propositions, I cannot do otherwise than refer with regret to two or three circumstances which, though insufficient to turn me from the task I have undertaken, are yet of a nature to render that task anything but an easy one. It is not easy, for instance, to deal single-handed with any movement which has acquired the dimensions and character of an agitation; with a portion of the Press, which has so far identified itself with that movement as to publish unwillingly, and frequently to suppress altogether, anything which tells seriously against it; with a sanitary authority which persists on issuing instructions, not for the resolution, but the preservation of the bodies of the dead. An agitation, again, is not always exactly scrupulous as to the methods it employs, and the Cremation Society, by heading its appeals "Cremation *v.* Burial," instead of "Cremation *v.* the Abuses of Burial," is no exception to this.

Again, though I refer to it with the greatest reluctance, no adequate idea can he had of the difficulties of the question with which I have undertaken to cope without some pre-

vious insight into the composition and character of the recent meeting of so-called Hygiene and Demography, because the present paper is the immediate outcome of that meeting. Composed as that meeting was of ladies ready to hold up their hands for whatever was most advanced, and of equally advanced cremationists in about equal portions—inordinately long papers were read at it, which largely transgressed the 15 minutes allowed for them, and which took up so much of the available time of the meeting as to leave exactly three minutes, and no more, for the defence of the more regular papers, of which due notice had been given, and which strictly conformed to the rules laid down for the guidance of their authors. No wonder that, when a resolution was proposed favourable to cremation at a meeting worn out by the reading of these long papers, no hands were found to vote against it; and that this same resolution should have been since paraded in all directions, and on every occasion, as a deliberate expression of European opinion. I say no more of it. On the other hand, if I had said one word less, I could have given you no idea of the uphill battle which it has devolved upon me either to abandon or to fight. Having premised, and, I repeat, most unwillingly premised, this much, I now proceed to the consideration of the propositions which stand at the head of this paper.

First, then, as to burial as it is. Burial as it is consists in this—in the hermetic enclosure of the dead body, which, instead of being buried at once, has been kept in the house till putrefaction has set in, in a strong air-tight box or coffin (of oak it may be, or even of lead), and in disposing of these boxes one upon another till a legalised piece of ground called a cemetery is full of them; then, in doing the same thing in another piece of ground till that also is full; then in a third till that is full; and so on, in one piece after another, till all are full—till the dead, in fact, are in permanent possession of all of them, or, as Lord Stowell pithily puts it, "till the dead have shouldered out the living." I have already said so much of this mode of burial that I need here say no more of it.

Burial as it ought to be, again, consists in the enclosure of the body as soon after death as possible (as soon, that is to say, as the *rigor mortis*, which is a proof of death, has passed off and before decomposition has begun) in a coffin as perishable as itself, and which allows of its gradual disappearance without harm to anything or anybody. For this method, or, rather, for this *principle*, of burial, I am myself entirely responsible, and if this principle were well understood, as I have described it elsewhere, I need not again refer to it. It is, however, even now, so much a sealed book to many, and possibly to many here, that I may, perhaps, be forgiven if I once more repeat what I said of it at a meeting presided over by Lord Shaftesbury many years ago:—

"It is the departure from the simple conditions which should attend the solemn act of committing a body to the earth which is the cause of all the evils that surround the subject, and which it is the aim of all I have written on the subject to mitigate, if not altogether to remove. The retention in a dwelling-house for as *long* as possible of a body, which ought to be committed to the earth as *soon* as possible, is the first departure of this kind. It is also the most important, because it is this departure which necessitates the strong coffin, and it is the strong, imperishable coffin again, which prevents the resolution which it is the beneficent office of the earth to accomplish, and which, therefore, it should be the first care of the living to promote. Some curiously mistaken notions exist as to what happens to a dead body when, in the words of the old ritual, it is 'laid into the ground,' the popular notion being that it becomes a part of that clay to which it is committed. Nothing of the kind, of course, is the case. A body properly buried—buried, that is to say, in such a way that the earth may have access to it—does not even remain in the earth, but returns to the atmosphere. Let me explain. Suppose a body buried three or four feet below the surface, the earth, as earth, affects it in no way whatever. The part played by the earth in its resolution is that of a mere porous medium between it and the air which is above it. Through this medium the air with its dews and its rain filters, and, when it reaches the body, oxidizes it, that is to say, resolves it into new and harmless products; and then these new products, passing upwards again through the same sieve-like medium, re-enter the atmosphere and become the elements of its renewal, and of the nourishment and growth of plants. The body, in fact, literally as well as figuratively, ascends from the dead, and fulfils the cycle of its pilgrimage by becoming again the source and renewal of life. . . . . yet it is this very provision which, with our strong imperishable coffins, we are doing our best to prevent! Another mistake, too, is to suppose that, after a time, this coffin itself decays in the earth. It does not. Substances only which contain nitrogen readily decay in the earth, decay being the effort of the nitrogen to get out. But wood is a non-nitrogenous body, and does not readily decay; so that, in the Holborn Burial-ground, the coffins of Charles II.'s time were found just as they were buried, and with their contents

just as putrid, while the surface had been raised no less than eighteen feet by this mass of boxed-up putridity. . . . . The coffin, therefore, should be of the lightest material, such as pulp, now in daily use at Woking. Moreover, as the coffin is the *fons et origo mali*, it should be the first object to remodel and reform."

I hand round a representation of one of these coffins, that those present may see not only what it is like, but that I do not, as a prominent member of the Cremation Society is fond of declaring, "bury in a basket." I may also state that as the patent for this coffin is out, anyone may make it, and—as its prime cost is small—sell it for much less than the Woking Company is now doing. Before I entirely quit this subject of "burial as it ought to be," however, I cannot forbear to express my gratification that authorities so eminent as Drs. Brouardel, Du Mesnil, and Ogier, of Paris, have since fully endorsed the principle on which it rests, especially as to the action of the air as well as the earth in promoting the resolution of the buried body. I append a note of their observations to this paper:—

On the Sanitation of Cemeteries.

1. If—say Messrs. Brouardel, du Mesnil, and Ogier*—when interments took place in churches, it was possible for accidents to result from the escape of putrefactive gases—in these days, when such gases are allowed to find their way into the open air, such dangers are imaginary; while the air of the open cemetery itself is absolutely free from all danger and odour, as the result of its admixture with such gaseous products.

2. That this soil contains large quantities of carbonic acid gas only, and of other gases—contrary to the general belief—none in any appreciable quantities.

3. That the decomposition of dead bodies buried in the earth is rapid, exactly in proportion as the soil is porous.

4. That in proportion as the buried body comes into contact with the outer air, by the fact of the permeability of the soil, and of the porosity of the coffin, its resolution is the more rapid and complete.

I now proceed to describe, as fairly as I can, what I understand by cremation. There are, however, I ought to say, two ways of describing it—the cremationist way and my way. The cremationist way—I quote from a letter I have just received from a very eminent cremationist—is this:—"Efficient cremation and efficient burial are the same processes differing only in time. I would recognise both (notwithstanding a case of poisoning here and there), though at the same time inefficiency in the performance of either should be made an offence." Then comes my way. I say that if these two things are the same in theory they are not the same in practice. That while burial is a complete process leaving no *residuum* behind it, cremation is an incomplete process, leaving a very positive *residuum* behind it, not to say a very embarrassing *residuum*. That while one, therefore, is an efficient and perfect process, the other is an inefficient and imperfect one, and, therefore, as my distinguished friend says, it ought to be "made an offence." That while, by burial, the body remains at rest till such time as its perishable parts re-enter the air, and its imperishable parts remain to form (as nature intended) an integrate part of the earth's substance—by cremation it is thrust into a furnace and, by the aid of one of those tall chimneys which we have been so long trying to get rid of, its combustible parts are poured—and that for two or three hours—into the pure air around, and its incombustible part (weighing from five to seven pounds, more or less), are returned to the mourners to take away with them! or "to be called for." What the effect on the surrounding air would be if a dozen, or twenty, or fifty, of such vomitoria were all at work at the same time, I leave to those whose fate it might be to live within half-a-dozen miles of them, to imagine. I might, if I thought it worth while, write a whole chapter on this part of the subject alone. I forbear out of regard to those present to do so, and to satisfy those who would know more of the wonderful properties both of the earth and of the air, content myself with recommending for their perusal the many instructive papers on the subject by our distinguished Chairman, and also a recent most remarkable paper on "The Nitrifying Ferments of the Soil,"* by Mr. J. M. H. Munro—a paper which ought to be all the more convincing in that it is not advanced by its author to uphold any preconceived theory. In that paper Mr. Munro tells us not only that nitrification (which is nature's way of turning all putrescent matter to a harmless and useful account) is impossible without the intervention of the earth, but that inoculation with even minute quantities of soil is sufficient to produce it. "The quantity," indeed, "of this most impor-

* Congress of Hygiene and Demography. London, 1891.

* "Journal of the Royal Agricultural Society." Third series, vol 2, p. 702 (1891).

tant factor," he says, "present at any one time in relation to the whole mass of soil, is so nearly infinitesimal that the most scientific chemical test will barely detect it." Sometimes, he goes on to say, "there is less than one part—often less than ten—of this nitrifying element in a million parts by weight of soil." If I have gone out of my way to quote what is said in this most interesting paper, it is because it comes to me as a revelation of that wonderful power on the part of a thin covering of earth to prevent any appreciable odour from the presence immediately beneath its surface of a dead body, at which I have always wondered; and because it furnishes a complete answer to those indiscreet and untruthful advocates of cremation who are always telling us of the pestilential vapours emitted by grave-yards.

II. To test the validity of a statement made by Sir H. Thompson at the recent Congress of Hygiene and Demography to the effect that Burial is a propagater of infection and a cause of increase in the zymotic death-rate.

In entering as seriously as I can upon this, the second head of this inquiry, I find myself, if I may say so, suddenly called upon to contrast what I have always believed to be the ways of Nature with the ways, opinions, and statements of Sir H. Thompson. If, as I must confess has been the case, I have hitherto believed the ways of Nature to have been for the general benefit, I must now, perforce, believe that they have been to our detriment. While Nature, up to now, has assured me that the great and universal disintegrator and destroyer of all forms of death and decay is the earth, Sir H. Thompson tells me that, in giving me any such assurance, Nature has deceived me altogether. On the contrary, that the earth is a very hot-bed of infection, and its water springs special carriers of that infection to the living. In a word, that while Nature has been doing one thing for the supposed welfare of the whole human race, Sir H. Thompson, for the purposes of the crematist propaganda, has been doing another. All that our chairman and Mr. Munro have told us of the wonderful nitrifying power of the earth on every form of animal decay—all that Sir John Simon and other eminent chemists have told us of its equally wonderful faculty of changing putrescent animal matter contained in water into neutral salts—all that we know of the complete cessation of cattle plague by the prompt burial of its thousands of carcases in shallow trenches—of the harmless resolution of hundreds of soldiers superficially buried on fields of battle—nay, even of the entire disappearance of the Great Plague itself after its victims had been cast by cartloads into pits dug for them in the open streets—all this, I say, and all that we observe every day in our fields and gardens, we must now be prepared to give up and, at the novel dictation of the cremationist propaganda, to forget and throw to the winds! If those who now listen to me, and who may not unnaturally suppose that these expressions convey something more than the circumstances warrant, I can only say that their surprise cannot equal my own, when I heard for the first time from Sir H. Thompson's own lips that "burial within the earth was a propagator of infection and a cause of increase in the zymotic death-rate."

Now, there are three ways of meeting this extraordinary statement—by the evidence of experts, by the teachings of bacteriology, and by the result of experience—each I might almost say sufficient in itself to refute it. I, however, at once made up my mind to avail myself, for this purpose, of all three, and also that I would depend by choice on my own experience of forty years first. Every member of the profession, of which I have so long had the honour of forming a part, knows that all infectious diseases divide themselves into two great groups or classes—one which derives its origin from surface soil and surface water—the other which owes its convection to actual contact of one case with another in the open air. Again, that the first of these classes is itself sub-divisible into two distinct types of disease—one which depends on vegetable exhalations from marsh lands, and which includes within it all those forms of febrile disturbance known as malarial; the other which, like cholera and choleraic diarrhœa, depend on the actual introduction into the intestinal canal by means of surface soil and surface water of the *dejecta* of other patients affected with the same disease. Burial, therefore, four feet below the soil, can have nothing whatever to do with any of those forms which constitute, as I have said, the first class of infectious disease. The second, and by far the larger class, again, and which comprises small-pox, measles, whooping-cough, typhus, and scarlet fever, owes its propagating power to the actual contact or close contiguity in the open air of one patient with another. That class, therefore, has no connection with either soil or water, and being wholly independent of

even the surface of the earth, can have even less to do with burial than the first class. To lump these two classes together, therefore, as Sir H. Thompson has done, is, to begin with, a scientific solecism of the most glaring kind, and, seeing how perfectly well known the superficial method of their propagation is, to pretend that they are spread by means of water when buried four feet below the surface, a statement which is perfectly inexcusable and in the nature of a direct appeal (for a purpose) to popular ignorance and credulity. The zymotic death-rate, in fact, has nothing whatever to do with burial, only two out of the seven diseases which comprise it having ever been shown to depend in any way whatever, either on soil or water, and none of them, except in the imagination of Sir H. Thompson, to have been disseminated by water. Where, I would ask him, is the water to do it? Water, except in the shape of rain, is never found at, or near, the surface of the ground, or within many feet of it. As we pass the excavations made for the foundations of a house, which excavation is much deeper than the bottom of the deepest grave, we see no water; or even in larger and deeper excavations made for the building of a church or a theatre; or for the laying of pipes, or even in deep railway cuttings. The cut edges of all these excavations and cuttings are, in fact, perfectly dry. Springs, again, come from a depth, and arrive at the surface by isolated channels of their own. Is not this story of the water, therefore, an afterthought, a pure invention, in fact, to tack on to, and account for, the statement that the buried body is a propagation of infection.

Bacteria, again, which are said to "swarm" (as if they were animals) in the earth and to "prey" on the buried body are minute cellular organisms, which multiply by fissure, and, like all other plants (including mosses and fungi), grow best when undisturbed. Like plants, also, they require for their growth carbon and nitrogen; water, also, and a certain temperature are necessary for the maintenance of their vitality. Like plants, also, by the disintegration of organic combinations containing nitrogen, they produce certain chemical products and, as fungi, assist fermentation. They vary, too, as to the amount of atmospheric air they require, some of them, like the bacteria of *anthrax*, being unable to maintain their vitality without it, and some being able to do with little (the so-called aërobic and anaërobic bacteria of Pasteur). That any of them, however, are able to do altogether without air I do not believe, and, therefore, humbly decline to admit these terms as warrantable. Like other plants, again, some are reproduced by spores, or seeds. When, by a linear arrangement of their primitive cells, they grow like rods, bacteria are called bacilli. Anthrax is a bacillus of this kind, and being, like *bacillus septicus*, what is (improperly) called anaërobic, dwindles and dies when deprived of air. If, therefore, the body of an animal which has died of anthrax is buried entire, *i.e.*, without being opened, the bacilli which characterise this form of disease die with it, and, notwithstanding statements to the contrary, not only die with it, but are incapable of reproduction. The infection of anthrax cannot, in fact, as cremationists declare, be spread when so buried. When, therefore, it has been reproduced in fields in which cattle infected with the disease have grazed, died, and been buried, the fresh outbreak is owing, not to the buried carcass, but to the spores which have been left by the *dejecta* of the infected animals upon the surface of the field in question. Both Klein and Koch are fully agreed as to all this, and Koch, in addition, has proved by direct experiment (Mittheil, a, d, k, "Gesundheitsamte," 1881) that the spores of anthrax are not, as Pasteur has stated, taken up by earthworms and deposited on the surface by their castings; and that the spores of anthrax bacilli, when mixed with earth in which worms are present, are not taken up by these creatures at all. Klein, indeed, carries these statistics further, and says: "If bacilli grow in the depths of a fluid medium—in a medium, *i.e.*, but scantily supplied with air—they do not form spores, and at length degenerate, and as the fluid dries up, this degeneration goes on till, finally, nothing is left of them but their *débris*. Such bacilli, of course, therefore, are quite innocuous when introduced into the tissues of animals, or into fresh nourishing media." (Klein, "Micro-organisms and Disease," ch. xi. pp. 155, 156. Macmillan, 1886.) Those, therefore, who have been able to follow me in this statement—a statement examined, re-examined, and confirmed by the most eminent men to whom I have submitted it (and, as I now understand to be admitted by Pasteur himself)—will see how little reliance can be placed on the reports spread broadcast over the country by the advocates of cremation, that bacteriology is fatal to the practice of burial, and, on the contrary, how

recommendatory it is of that practice, and how adverse to cremation. So much for the bacterial bugbear.

Lastly, and as my strongest point of all, I addressed to such medico-legal authorities as I thought best qualified to answer it, the following question :—"Do you, or do you not, agree with a statement made by Sir H. Thompson, at the Congress of Hygiene and Demography, that a human body, dead of an infectious disease and buried four feet below the surface of the ground, is capable, by water percolating the soil, or by any other known agency, of propagating the infection of that disease—or of any one of those diseases which are understood to comprehend the zymotic death-rate; has any case of infection so conveyed ever occurred to you, or come within your observation or knowledge; and, the present state of sanitary science considered, do you believe in the probability of such conveyance?" The answers to this question, though too variable in terms to be reproduced separately, I am justified in saying, amount to this :—"The statement you refer to is not consistent, either in part or in the whole, with the trained observation and experience of this country. Of the seven diseases known as zymotic—namely, small-pox, measles, scarlet fever, whooping cough, diphtheria, enteric fever, in various forms, cholera, and diarrhœa—the first five require for their propagation contact, more or less complete, in the air, and the last three the actual introduction into the alimentary canal (which is the seat of disease) of animal dejecta by surface soil or surface water. To include in one common category all these diseases as if they had a common origin is, to say the least, unscientific, and—the nitrifying power of the earth on water charged with animal matter considered—in the highest degree improbable, if not impossible. No known warrant exists, in fact, for any such statement. If, out of the hundreds and thousands of these diseases which have come under observation within the last twenty years, any one of them has proceeded from or depended upon, the neighbourhood of burial places in which such cases had received interment, all we can say is that the fact, if it has ever occurred, has been overlooked with singular uniformity by scientific observers."

I consider, therefore, I am now justified in putting to Sir H. Thompson the following questions :—

1st. When, where, and by whom has any outbreak of small-pox, measles, whooping cough, or typhus been shown to be due to water-borne infection?

2nd. When, where, and by whom has any water-borne epidemic, or any other specific disease been shown to be due to specific contamination from a burial-ground?

3rd. When, where, and by whom has any zymotic disease whatever been shown to be due to interment, when carried out four feet or even much less below the surface?

4th. When, where, or by whom has even increased general sickness, or increased general mortality, been shown to be caused by interment?

5th. What definite statistical evidence, in fact, is there to show (*a*) that the general death-rate, or (*b*) the zymotic death-rate, or (*c*) the death-rate from any group of diseases, or (*d*) the death-rate from any disease, zymotic or otherwise, has ever been affected by burial, even under the present objectionable conditions?

And if Sir H. Thompson cannot, or will not, answer these questions, will he correct the dictum current in Manchester and other cremationist centres, that it is now "a recognised principle that contagious diseases (*sic*) are so spread"—a statement which is going the round of the cremationist Press, and which is depended upon as a warrant for the erection of crematories in Manchester, Liverpool, Bristol, Darlington, &c.; and, further, is he aware that the inducement openly held out to would-be shareholders in those ventures is in no respect a sanitary object, but the dividends which their promoters declare they cannot fail to yield? I very much doubt whether Sir H. Thompson will find it convenient to answer these questions. If he will not, I call upon him, at all events, to furnish the provincial Press with such a correction of Mr. Chancellor Christie's statement at Manchester as will, at least, go to prove that cremation is a hygienic, and not a speculative, movement.

IV.—Cremation an Incentive to Crime.

I now, and I trust for the last time, come to that part of the subject which no cremationist, if he can help it, is willing to hear mentioned—which the newspapers engaged in the cremationist propaganda are careful not to discuss—and which, whatever the momentary success which may attend, or appear to attend, the agitation of the question, will assuredly,

sooner or later, provoke the repressive action of the law.

With this part I may at once explain I have done precisely as I did when dealing with the sanitary part of the subject—put myself, that is to say, into personal communication with those members of the medical profession who, better instructed than myself, have had to cope with such cases in the courts of law, and whose experience is to be found in a concentrated form in the text-books on medical jurisprudence.

Taking note of Sir H. Thompson's statement to begin with, that "only 102 exhumations had been made during the last twenty years and only one murder a year been discovered by them," I first applied to the proper official quarter for the record of such cases, and learnt, not only that no such return had ever been made, or was likely to be made, but that inasmuch as such return, if made, would not include the exhumations ordered by coroners, it would not be accurate.

From Dr. Thomas Stevenson, again, the eminent Government analyst and editor of Taylor's great work on medical jurisprudence, I learnt that, "though he could not recall without great labour, all the cases he had met with, he had, yet, not only discovered poison by their exhumation, but had been able, by such exhumation and analysis, to prove the innocence of suspected persons."

From Mr. Thomas Bond, consulting analyst to the Westminster Hospital, I learnt that though, like Dr. Stevenson, he could not furnish particulars of every case he had had to do with years ago, he had yet had no less than four such cases in the course of last year (1891), all of them proving, by exhumation of the body, murder by arsenic; that this year (1892) he had made two such exhumations, which proved to him that a double murder had been committed—a man, in one of them, having been shot from behind at a distance of six feet or thereabouts, and a woman, also in the back, at a distance of one foot, a coroner's jury, however, having found the wounds in both cases accidental, and the result of a struggle between the two. That, on another occasion, he had exhumed a body after two months' burial, and found that death had resulted from the performance of an internal illegal operation, and that he had had a similar case since. That, in the case of Harriet Lane, murdered by Wainwright, after twelve months' burial, and though an attempt had been made to destroy the body by quicklime, he had proved murder by a bullet wound in the brain. That in the case of the Austrian, De Tourville, who killed his wife on the Stelvio, the case brought home to him had turned out, by exhumation of the bodies, to be only one of several, one of the victims being his first wife's mother, whose death, after twelve years' burial, was shown to have been caused, not, as was certified, by an accidental wound in the eye, but by a shot from behind. Mr. Bond, too, ends his letter with this pertinent reflection, that "he had no doubt that many persons skilled in the use of poisons would more frequently resort to them if it were not for the knowledge that their operations were liable to be handicapped by exhumation."

Mr. Lowndes, again, the well-known surgeon of the Liverpool police, reports in the *Times* an equally instructive case. In this case two women, Higgins and Flannigan, had combined to murder, and did murder, by means of arsenic, a man of the name of Higgins, the husband of one of them, the crime being discovered by a *post-mortem* examination of the body before its burial; and that this murder had brought to light, by exhumation, no less than ten others by the same women, at the examination of three of which he (Mr. Lowndes) had himself assisted, the cause of death in all of them having been certified to have arisen from poison. Yet, that as the case of the man Higgins was complete in itself, and the exhumation of the ten others had been merely "corroborative, not essential," to the discovery of that case, therefore, they ought not to be counted, and need not, in his (Mr. Lowndes's) opinion, stand in the way of a fair trial to do without exhumation!

Quitting, however, these cases, the result of current experience, and going for further information to the text-books which positively bristle with them, we find in them abundant evidence of how fatal it would be to the ends of justice to do away with exhumation and to rely on certificates merely. I need only refer here to a few of them. A man of the name of Winslow poisons his mistress by antimony; three other of his relatives are exhumed in consequence, and all of them are proved to have been put an end to by the same poison, notwithstanding which, and for some reason, satisfactory, possibly, to a cremationist, the man was acquitted. At Bilston, three children die in one family, antimony being found in the bodies

of two of them, and, two months' afterwards (by exhumation), in the body of a third, the cause of death, in the last case, having been certified as "asthenia and gastric fever." Mary Ann Cotton, again, poisons her stepson, whose body, being exhumed, is found full of arsenic; whereupon, further exhumations bring to light the cases of no less than 19 other persons, all of whom had been murdered by arsenic, viz., those of her mother, 15 children, three husbands, and a lodger, making up the ghastly roll of 20 in all. The case, however, most to the point for the purposes of such a paper as this, because of the extraordinary opinions it elicited as to the "cause of death," is undoubtedly that of William Palmer, executed at Rugeley for the murder of J. P. Cook, because, in that case, the murderer would, undoubtedly, have got off but for the exhumation of six others of his victims, all of whom were found to have been murdered by him with the same motive, though not always (he being an expert) by the same means. I lay peculiar stress on this case, because it furnishes a complete answer to those who, like Sir H. Thompson, Mr. Lowndes, and others, seem to think that, with a better system of certification, we may safely do without exhumation. Alas, medicine is not, and never will be, the exact science which such reasoning supposes, and, under no conceivable circumstances, shall we be able, without such ocular demonstration as exhumation affords, to say—with anything like certainty — that such and such symptoms as are compatible with death from natural causes are not also compatible with death by poison. Palmer, for instance, poisons Cook by a mixture of strychnine and antimony. The strychnine kills, and the poison is removed by the vomiting purposely (?) set up by the antimony. At all events, neither poison is found in the unburied body in sufficient quantity to warrant a conviction for murder. Moreover, the action of both these drugs is so consistent with the symptoms of certain forms of disease, that no two medical witnesses, dealing with that case alone, could be found to say with certainty to which category they belonged. "Bilious cholera," "epilepsy with tetanic convulsions," and "angina pectoris" were each, in fact, certified by eminent practitioners as the cause of death, one of these gentlemen going so far as to write a pamphlet to show that the others were wrong! Now what, I ask, would have been the result in this most instructive case if it had not been for exhumation. First, while the case of Cook is under examination, the body of Ann Palmer, Palmer's wife, after fifteen months' burial, is taken up, and murder by antimony discovered, "bilious cholera" having been certified as the cause of her death. Two medical certificates had also been given to the same effect, which, says Taylor, in narrating the case, "coupled with the social and professional position of the murderer, checked all suspicion." Walter Palmer, again, on whose life his brother had effected insurances to the extent of £82,000, was poisoned by him with prussic acid, and it was on the strength of their discoveries that the body of Cook, being exhumed, was again examined, and then it presented all those appearances which are now known to depend on poisoning by strychnine—the toes and hands being still flexed, and the limbs rigid. These, with others, nine in all, if not more, would, but for exhumation, never have come to light; nor would Palmer himself have been convicted. And again, may not exactly the same thing be said, notwithstanding an extraordinary amount of special pleading in the *Times* by Sir H. Thompson, of the case of Neill and his four victims? If, instead of being available for exhumation, the bodies of these four poor creatures had been cremated, where would Neill be now, and what would he be doing? True, in his last letter to the *Times*, Sir H. Thompson "hopes" to be able to "devise" a death certificate which may be depended upon as a safe warrant for cremation. He may hope, but if he will read, not our English books (for we are terribly behind-hand on the whole subject), but the French and German standard works which deal with it—"Briand et Chaudé" in particular, and the several able contributions to the same end by Brouardel—he will see how vain (without proceedings which the amateurs of cremation would never hear of) that hope would be. Nay, he would also find this—that however advanced on all such matters both these continental nations are, no such certainty has ever been arrived at even by them.

I did, indeed, after one of these confident letters of Sir H. Thompson to the *Times*, write to that journal, and point out how constantly a second and even a third examination was found necessary to correct the errors of a first. The editor, however, did not put it in, confident, no doubt, that it was only a piece of captiousness on my part, and little knowing that the very existence and future legality

of cremation depends upon the possibility of these secondary examinations. The suggestions of Dr. Brouardel on this part of the question are, in fact, invaluable, and sufficient in themselves to set at rest the ignorant pretensions of the Cremation Society for ever. I have by me, and been able to bring with me to-night only, a short report by this eminent *expert* to the French Government on this very matter. It is enough, however, to satisfy anyone of the absolute necessity not of one but of several *post-mortem* examinations of the same case before the death certificate could be arrived at; yet, so loosely are we forming our opinions on this all important fact, that when I wrote to the Editor of the *Times* to tell him so, he put—or at least I presume he put—for it has never appeared—my letter into the rubbish basket! Well, I am quite content to wait. Meanwhile, another proof of our imperfect understanding of the seriousness of a subject which we thus dispose of so easily is to be found in the common belief that it is only in cases of poisoning that we need apprehend any difficulty in making out a satisfactory death certificate. Alas! as Dr. Brouardel shows, poisoning, though in these days of vegetable alkaloids a difficult crime to be sure of, is by no means the only crime to puzzle the medico-legal expert. I am not now speaking of cases in which death was the invariable result. I hold in my hand a return of cases of all forms of crime which this gentleman alone has been called upon to deal with in the course of six years—that is to say, between the years 1878 and 1883, both years included. It will astonish those, I think, who heard Sir H. Thompson say at the Congress of Hygiene and Demography—(he has corrected it, I see, since)—that only one murder a year was discovered by examinations of this kind—examinations undertaken not only for the discovery of cases of poisoning, but of crime of all sorts. After quoting no less than 505 examinations undertaken by him in these six years of attempts on the life of adults alone —(cases of infanticide are, it appears, far too common in France to be even mentioned among them)—359 yielded results of a nature to lead to a conviction, while 146 were insufficient to do so; and this accords with Dr. Stevenson's experience when, in his letter to me, he says that while he had often been able to detect crime, he had also not seldom been able to prove the innocence of the suspected person. I must not take up the time of the meeting by going through the long list of crimes of all kinds which Dr. Brouardel had to deal with; but it will, I am sure, surprise many who hear me, that poisoning formed but a small part of them—but thirty-nine, in fact, while in forty-two no poison was discoverable, and the natural death certified. I have, however, quoted enough to show the very onerous and responsible nature of the task which the Cremation Society is taking on itself so easily, a responsibility the degree of which the newspapers which support them can have no idea, and of which, it is equally clear, they have no idea themselves. Meanwhile, for the purposes of this paper, I am content to depend on the case of Palmer alone, as a case which, since it puzzled half-a-dozen medical men, would certainly have puzzled the all-sufficient expert—whoever he may be—depended upon by the Cremation Society!

V.—Conclusions.

I have now done, and the conclusions I have now arrived at—many of them I may say forced upon me—are as follows:—

1. That owing to the one-sided statements put forth by the Cremation Society, a very general impression has been created that there is only one kind of burial and only one remedy for it—cremation: a statement which is entirely misleading.

2. That this belief has been greatly assisted by the systematic suppression on the part of an influential portion of the Press of all effectual answers to the cremationists' statements, and, that in this way, the country has become flooded with these unopposed statements.

3. That the Government, as represented by the divided authority of the Home-office and the Local Government Board, is equally to blame for allowing the abuses I have pointed out to go on, and is, therefore, to that extent, responsible for the cremationist agitation.

4. That burial, as at present carried out in coffins which prevent the resolution of the body, is equally a reproach to the intelligence of the country and to the Government that permits such a practice.

5. That to make the practice of burial perfectly harmless, and to do away with all excuse for cremation, nothing more is necessary than to take this matter of the coffin out of the hands of the undertaker, and to make its structure and composition a matter of municipal regulation.

6. That while burial, properly conducted, is

a complete and perfect process, leaving no *residuum* behind it, cremation is an incomplete and imperfect process, leaving a considerable and very embarrassing *residuum* behind it—a *residuum* equal in bulk and weight to $\frac{1}{20}$th part of the whole body, and for the disposal of which it makes no provision whatever.

7. That while the earth properly used is capable of disposing of any number of dead bodies, and of disposing of them silently and with advantage both to its own substance and to the air above it, the practice of cremation on a scale large enough to have even the slightest influence on burial either as a rite or as a custom, supposes the necessity not of one but of many furnaces with tall chimneys, the use of which in towns no municipal authority in its senses would for a moment permit; and which in the open country would cause such a consumption and carbonisation of pure air as to render (changes of wind considered) a large area in the neighbourhood of such chimneys uninhabitable.

8. That the natural destination, therefore, of all organised bodies that have lived and that die on the earth's surface is the earth.

9. That the evils supposed to be inseparable from the principle of interment are independent of that principle, and are of our own creation.

10. That the source of these evils is to be found, not in the burial of the dead, but in the unreasoning sentiment which prompts us to keep them unburied as long as possible, and then to bury them in such a way that the earth and the air can have no access to them.

11. That the principle of burial supposes the resolution of the body by the agency of the earth to which we commit it, and that the earth is competent to effect that resolution, and to effect it innocuously.

12. That to seek to prevent the beneficent agency of the earth by enclosing the dead in imperishable coffins, brick graves, and vaults, is in the highest degree irrational, since it engages us in a vain resistance to an inevitable dispensation, and has led us to accumulate in our midst a vast store of human remains in every stage and condition of decay.

13. That unwarned and undeterred by the magnitude of the evils we have thus created, we are still, by the instructions issued by our sanitary Boards, engaged in extending and perpetuating them.

14. That were the dead only properly buried, not one of those evils would have any existence, not a single dead body would remain to encumber the soil, and a quantity of land of incalculable value, now hopelessly alienated, would be liberated for purposes of hygiene and of utility.

15. That the remedy for such evils is, therefore, not in cremation or in any of the alternatives that have been proposed for burial, but in a sensible recognition of, and a timely submission to, a well-defined law of nature, and, since some of these alternatives are dangerous, in legislative action to enforce the provisions of that law.

16. That Sir Henry Thompson's extraordinary statement that burial, however, conducted, is "a propagation of infection and a cause of increase in the zymotic death-rate," is absolutely without warrant, and abundantly disproved by expert evidence from all parts of the country.

17. That water is not, as he has stated, a carrier of any one of the contagious diseases which comprehend the zymotic death-rate.

18. That bacteriology, so far from adverse to burial, is distinctly in favour of it.

19. That Sir H. Thompson's further statement made at the Congress of Hygiene and Demography, as to the number of exhumations made, and of murders discovered by them, is absolutely incorrect, unless he counts Palmer's six cases as one, De Trouville's seven as one, Higgins's and Flannigan's ten as one, Cotton's twenty as one, and so on.

DISCUSSION.

The CHAIRMAN was quite sure they had all listened with a great deal of pleasure to the very able paper read by Mr. Haden. The last part of his paper, to the effect that cremation did away with the possibility of exhumation, was self-evident, and, if cremation became general and exhumation became impossible, he confessed it was rather like taking down the notice "Beware of the dog," which kept felons and others out of their houses. The taking down of that little notice "Beware of the dog," (*i.e.*, the person who exhumed the body and found poison), might have very untoward consesequences. But he had not hitherto looked upon this question—the inability to practice exhumation—as one of the great arguments against cremation. He was ready to yield the exhumation question to the cremationists, and yet he would still tell them that cremation was hopelessly in arrear of the science of the time, and that, from economic and sanitary reasons, it ought not to be recommended. With regard to the question of zymotic diseases, he confessed that zymotic

diseases may have originated from grave-yards. He admitted the possibility of it, but the facts were very scanty, and they certainly wanted confirmation. He was speaking that afternoon to a friend of his, a noted hygienist, and he was likewise of opinion that the facts against grave-yards were extremely scanty. Now there was no doubt whatever that cholera was conveyed by water.

Mr. Seymour Haden—Surface water.

The Chairman—Well, surface or river water and well-water, but how had that water been contaminated? The water which had conveyed cholera had always been contaminated by leakages from cesspools or sewers. The upper layers of the earth were full of bacteria—the nitrifying organisms described by Professor Munro. If, consequently, they buried organic matter in the upper layers of the earth, the nitrifying organisms would get hold of it, and the body, or excremental matter, would be turned into nitrates and nitrites. The soil itself was the most perfect filter for bacteria which was known, and if the organic matter be buried near the surface of the soil, the filtration of the bacteria into wells was impossible. A cesspool was another matter altogether What was done here? Here was a pipe which perforated the upper layers of the soil and took the foul water into the cess-pit. The water collected in the cesspools, which, in consequence of the pressure, began to leak, and allowed the foul matter to percolate into adjoining wells. That was how accidents occurred, but there was no analogy whatever between foul water in a cesspool and a body buried in the upper layers of the earth. He absolutely and cordially agreed with what Mr. Haden had said—viz., that burial as a means of communicating zymotic diseases was a mere nothing, and that what had been proved against burial, even unscientific burial, was a mere nothing. Now, he should like to say that, if they were to compare cremation and burial, they must be very careful to separate essentials and non-essentials. The simple act of interment has, owing to superstition, vanity, and ignorance, become encumbered with a number of ceremonies which all felt to be exceedingly oppressive. He believed that the limited popularity, if he might say so, that cremation enjoyed was created by being able to avoid these very embarrassing and trying ceremonies. But these were not essentials either to burial or cremation. In cremation they put the body into a hole in a furnace, aud in burial they put the body into a hole in the ground. If they were to compare the two acts, they must be compared simply like that, quite independently of other concomitants. In the case of death, it was absolutely essential to make preparation for the transport of the body, so that it might be decently placed in the hole; whether that hole be in the ground or in the furnace really could make no difference, except that earth burial required no special machinery, and was infinitely quicker. Tne grave could be dug, the body put in, and the whole covered in again in ten minutes or a quarter of an hour. The next point was that if burial was to be perfected they must follow nature's law. Mr. Haden was quite right when he said that the destination of all dead organic matter was the earth from whence it came, and that to purify the earth you must grow something on it. It had been the wise custom to grow trees, shrubs, and flowers in the cemeteries in this country, and to make them look beautiful. The cremationists said that burial in the earth was too ghastly a subject for public discussion, but why he was at a loss to understand. From the æsthetic point of view all the advantage was on the side of burial. If the body was properly buried in the earth, all trace of it would disappear completely. The rain falling upon the earth dissolved out the nitrates, and carried fertilisation wherever it went. It must be admitted that it was their duty to return to the earth whatever came out of it. At present, in their great cities, all organic refuse was burnt or turned into the rivers. They swallowed the camel of poisoned rivers, and strained at the gnat of earth burial. If, in addition to that, they had cremation of the dead, the air would be rendered more foul, and the earth would be starved. Cremation was a destructive process, whilst inhumation was a productive process. If they put a body into the earth, it must bring forth. It might shock some people to hear a body spoken of as productive, but it could not help being productive. It would bring forth food for the starving, clothes for the naked, warmth for the shivering, and work for the unemployed. If they were going on as they were going, if they starved the earth, and if, as a matter of strict principle, they did not return organic matter to the earth, there could be no doubt whatever that such a line of policy would do for this country what a similar line of policy had done for the Campagna round the city of Rome. He should like just to say a word on the financial side of the question. If a burial ground be properly used, an acre of ground would provide space for 3,630 adult people. They were told that land was not to be got. He was sorry to say that land was never so cheap as at this moment. Land could be obtained at £20, or even £10 per acre, and any land suitable for agricultural purposes—anything except a stiff clay—was suitable for burial purposes. He had read in "Chambers's Enclyclopædia" that the cost of fuel for cremating each body was 7s., so that it would require 1,210 guineas' worth of fuel for 3,630 persons. Therefore, on the economical ground, they might have to give 1,210 guineas an acre before cremation could compare in its financial aspects with burial. He bought the other day a small parcel of land, 66 miles from London and five minutes' drive from an important railway junction. It was farm land, and he gave 30 guineas an acre for it. It would make an excellent cemetery, and if 3,630

persons per acre were buried in it, the cost of interment for each person would be twopence. He was setting aside all extraneous matter, as, of course, they might have plumes, and feathers, and hearses, and all kinds of things. If, however, they made inhumation as simple as cremation, then on economic grounds burial was much better than cremation. But supposing that land was to become very dear indeed, inhumation scientifically conducted would enable the ground to be used over and over again. As to when the earth would be ready again after the ground was once full of graves he could not definitely say, but it certainly might be done after the lapse of a generation. He would not propose a shorter date. There was one other point. If inhumation was properly done, there was no reason why the burial ground should not be moderately close to a city. Burials conducted on scientific lines, so far from contaminating the air, tended to freshen it by causing to spring up trees and shrubs, the leaves of which gave off oxygen. On the other hand, cremation furnaces would give off the products of combustion, all of which would go to poison the atmosphere. He noticed that one person who now advocated cremation was very prominent in his efforts to reduce the smoke of London, and to open disused graveyards as playgrounds for children. This gentleman, by advocating cremation, would add to the evil he sought to diminish. He did not think it necessary to say anything further, except this, that burial, as compared with cremation, was simpler and cheaper; that it was a productive process, and not a destructive process; and that it freshened the air, and did not foul it.

Mr. J. C. Swinburne-Hanham, Hon. Secretary of the Cremation Society of England, did not think that the chief object of the meeting that evening was to discuss the details of cremation, or even its sanitary aspect. They were present to discuss the question from a medico-legal standpoint—the reader of the paper asserting that cremation was an incentive to crime. The Chairman had, however, wandered from that point, and had even gone into figures to demonstrate the correctness of his assertions. Dr. Poore had given them his idea of the cost of scientifically conducted burials; but anyone connected with burial boards in large towns would know that land very frequently reached 1,210 guineas an acre, which was the sum the Chairman had estimated for the cost of fuel in cremating 3,630 persons. Then they had to consider the fact that more than an acre was bought, and that it cost something to dig and fill in a grave. As a means of testing the relative cost of cremation and burial, he should advise anyone in doubt to ascertain the cost of the humblest grave ever allotted to a pauper. He was not there to defend Sir Henry Thompson, or to deal with the question from a sanitary point of view. The sanitary side of cremation and burial had been discussed over and over again, and he believed it was not denied that the present system of interment in and around towns was a source of danger to the population. That difficulty was met by the suggestion that the burial grounds should be in a locality some distance away, but then there had to be reckoned the cost of moving the body. Cremation was said to be an incentive to crime, because it precluded exhumation; but exhumation was not an effectual security against crime committed by poisoning. There were practically only three poisons, which were mineral ones—viz., arsenic, antimony, and mercury—which could be reckoned on as likely to be detected by exhnmation, for distinct traces of vegetable poisons were sooner or later lost by decomposition. Decomposition of the tissue itself produced new poisons, which, associating with those that caused death, complicated the steps of subsequent inquiry. It was essential that evidence of crime, to be of use, must be unquestionable. Exhumations were of rare occurrence, being five per annum. Moreover, skilful poisoners would avoid using mineral poisons. The French case of De la Pommerais showed the inefficiency of exhumation, as it afforded no direct evidence of poisoning, and it was only by the analysis of vomit scraped from the floor that this was obtained. Evidence of crime should be obtained at once, and, where cause of death was doubtful, an examination should be made forthwith, while the traces were distinct. The practice of the Cremation Society of England was to require two independent medical certificates, stating clearly what was the cause of death, before they cremated a body. In doubtful cases a *post-mortem* was made. Not long ago a doubtful case came before the Society; an examination was made, and a portion of the stomach and viscera removed, and preserved in a sealed jar. This should be done before cremation in all doubtful cases, and if it was, would be a formidable deterrent to the secret poisoner. The Cremation Society of England did not deny the need for regulations controlling cremation, and urged the reform of the present system of granting death certificates on the model of the French system. If this obtained in England, the events connected with the death of the unfortunate Matilda Clover would have been made known directly it happened, and before she was buried. No system of death certificate could be infallible. They could only do their best to make it as perfect as possible, and, having done so, even should an occasional poisoner escape detection, when it was remembered how serious were the evils arising from burial in the earth, the balance of advantage was clearly on the side of cremation.

Mr. John Leighton did not consider it necessary in a suitable soil, such as at Woking, to do away with the ordinary coffin. Except in a stiff clay soil it would quickly resolve itself.

Mr. Oliver Williams said he had read some of the publications of the Cremation Society, and he

could bear out the contention that the greatest possible care was taken as to medical certificates. He himself would prefer being cremated, and if he were a poisoner would rather run the risk of poison being found in the body after burial than at the strict examination preparatory to cremation.

Col. ALLAN CUNNINGHAM thought that burial two feet below the soil would affect the surface water feeding surface wells. Many of their large towns now obtained their water by surface drainage, though of course, as far as possible, they always took an unsuspicious locality. He did not think they would be justified at present in taking a drainage area within which were surface burial grounds; that was where the bodies were not more than five feet deep. It all came to this. If they put too many bodies on to one piece of land, the nitrifying power of the soil would be too much taxed. The general gist of the paper they had heard read was that there was proper and improper burial, and that proper burial was burial at shallow depths. There were many other processes of burial to be tried. The Hindoos burned their dead—that was, they did it theoretically. They used to burn them when fuel was cheap, but nowadays they used very little fuel, the body being thrown into the river and carried off that way. The Parsees exposed their dead on towers, so that the bodies might be eaten by vultures. That was one mode of getting rid of organic matter in a healthy way. The Mahommedans and Christians in India buried their bodies, but they saw in that one country three processes going on with respect to the disposal of the dead. All the evils resulting from burial resulted from burying too close and from burying in permanent material.

Mr. SEYMOUR HADEN, in reply, said he had been trying his very utmost to compose himself for the reply to Mr. Swinburne-Hanham. He had never in his life heard such confused statements upon any subject whatever, and he could not for the life of him gather anything out of them except the one statement that cremation was better than burial. Mr. Hanham did say one thing which struck him as very odd. He said that only five exhumations a year took place. Why four took place in a fortnight only a short time ago. These were furnished by the bodies of the four poor girls murdered by Neill. The French case alluded to was a case directly in favour of burial. The first certificate utterly and entirely failed, and nothing would have been discovered if, on a second examination, some vomit had not been found on the floor. In the case of cremation, no such examination would, in the first case, have been possible. Mr. Hanham had said that the evidence should and could be obtained directly. Even in France and Germany, where their system is far better than in this country, it has been found, by experience, that evidence could not be obtained directly, and, as he had said in his paper, a second, third, and even a fourth examination was sometimes necessary. Was it to be imagined that any expert, however clever, was able to discover all things at once? Was it possible for the experts of the Cremation Society to say at once that they were right? What was there about this society which made it infallible? It was nonsense. Somebody had asked how long a body remained in the earth. That altogether depended upon the character and porosity of the soil, but it might be anything, from three to seven years. He recollected exhuming the body of a pony that had been buried in clay. He expected to find it entire, but, as a matter of fact, he found nothing but bones. The reason of that was, that the pony was superficially buried, and, the clay cracking with the heat, allowed the air to reach the body and oxidise it. He had never said that nothing remained in the soil. The bones remained in the soil, and they remained there for the purposes of the soil, but all the perishable part had dissolved into the atmosphere, and went to the nourishment of plants, as the Chairman had said. The earth had, in fact, been, since the world began, the recipient of a mass of dead matter, which was only equalled by the sum of animal and vegetable life growing on its surface. To return dead matter to the earth is but the necessary step to its revivification and reanimation. Throughout the globe death and decay go to the maintenance of life, to the purification of the atmosphere, and, in a word, to the reformation and establishment of the beauty and healthiness of the earth's whole surface. Every thing that ever lived upon the earth went back to the earth, a fact which admitted of no dispute.

The CHAIRMAN explained, that on the financial question he left out altogether the cost of the plant and the wages of the stokers, which would be a considerable item in the cost of cremation. With regard to the decay of organic matter, Professor Fowler, at a debate on the subject, said that he had had a whale sent him for preservation in the Hunterian Museum. He had had a great experience in the preparation of whales, so he had the carcase superficially buried in ground just outside a wood. At the end of two years, he found that all organic matter had gone, a beautiful skeleton alone remaining.

A vote of thanks to Mr. Haden concluded the proceedings.

Miscellaneous.

THE INDUSTRIES OF DAMASCUS.

There are a considerable number of important industries in Damascus, of which the principal is the weaving industry. Her Majesty's Consul at that place says that there are some 2,000 hand looms for cotton, silk, and wool weaving. The cotton

looms turn out calico curtains and divan covers, stockings, sheets, girdles, surcingles, the stuff used for the long coats (*gumbaz*) worn by Moslems, and for the *izars*, or cloaks which cover the native women from head to foot. A hand loom can turn out thirteen yards of striped cotton cloth per diem, but the average day's work does not exceed seven yards. Taking 250 working days in a year, as there are numerous holidays, the total output for 1,000 looms would amount to 1,750,000 yards per annum. The cotton looms are constantly at work, not so the wool and silk looms; but yet the manufacture of *cottoni* (which is a stuff made of silk and cotton for upholstery), of puggarees, curtains, tassels, *izars*, and handkerchiefs, all of silk or silk and cotton mixed, occupies a large proportion of the working classes. There is also a small amount of wool stuffs manufactured. Rope-making also gives employment to a large number of persons, as also ornamental harness and saddle-making. Harness for mules and camels is made of wool leather, and ornamented with beads and shells. There are also many dyeing establishments. These are principally engaged in dyeing cotton cloth with indigo, for the clothing of the poorer class, but there is also a considerable business done in fancy colours for curtains, *izars*, &c. Other industries are hammered iron work, copper work, ornamental brass work, and mother-of-pearl inlaid work. The two latter are chiefly supported by travellers, who pay exorbitant prices, and who have spread the taste for these articles in foreign countries, with the result that last year about £9,000 worth of brass trays and inlaid tables were exported.

Notes on Books.

THE STANFORD DICTIONARY OF ANGLICISED WORDS AND PHRASES. Edited for the Syndics of the University Press by C. A. M. Fennell, D.Litt., Cambridge. 1892. 4to.

Mr. J. F. Stanford, F.R.S., who had made large collections towards the compilation of a Dictionary of Anglicised Words and Phrases, bequeathed £5,000 to the University of Cambridge for the production of such a Dictionary. The University accepted the bequest in 1882, and the Syndics of the University Press appointed a committee, consisting of Professor Mayor, Professor Skeat, Professor Bensly, Mr. Aldis Wright, and Dr. Postgate, who prepared a scheme of such classes of words as were to be included in the Dictionary. Dr. Fennell was appointed editor.

The main objects of the work are thus stated in the introduction.

"*Firstly*, to enable the English reader to find out the meaning and history of the foreign words and phrases which occur so frequently in English literature; *secondly*, to register the increase of the English vocabulary, directly due to the adoption and naturalisation of foreign words since the introduction of printing; *thirdly*, to record all English words of foreign origin which have retained or reverted to their native form . . . . More than 50 per cent. (*i.e.*, more than 6,400) of the articles of the Dictionary and Supplement are devoted to the first object which is popular."

The editor has had the greatest difficulty with the section that includes "all words borrowed from French, Latin, and Greek since the introduction of printing, whether now altered or but imperfectly naturalised, and now obsolete." From this class, all words found in Middle English were to be excluded, and, as there is no full register of such words except the "New English Dictionary" of Dr. Murray and Mr. Bradley, which has not at present proceeded far in the alphabet, the editor was in danger of including words which should properly have been excluded.

"The Dictionary" (including the Supplement) contains 12,798 articles (which treat of 13,018 words and phrases) and 2,708 cross references. The 12,798 articles are concerned with 10,927 words, 1,813 phrases, and 278 quotations, proverbs, or maxims.

An asterisk is prefixed to every article for which materials were found in Mr. Stanford's collections, which materials, in many cases, consist of a number of extracts from periodical literature and newspapers. An asterisk is also to be prefixed to all quotations taken from Mr. Stanford's collections.

A casual glance through its pages will show how large a proportion of the Dictionary is the work of the editor, both in words and illustrative quotations. As stated above, most of Mr. Stanford's quotations were taken from newspapers and other contemporary periodicals.

The large mass of quotations from old English literature are therefore almost entirely due to the editor and his staff of voluntary helpers. In fact Dr. Fennell has been so fortunate as to find in a few instances earlier references to the use of certain words than those given in the "New English Dictionary." The editor has not loaded his work with such native words as modern travellers and novelists are in the habit of introducing into their books with the object of giving "local colour," but which are not used by other writers and cannot be said to be anglicised.

As a rule the etymology has been confined to the indication of the language from which a word or phrase has been borrowed, and of its native form and meaning but in a few instances, where fresh light could be thrown upon a derivation, full etymological paragraphs have been added.

It is not easy in a short notice to give a clear idea of the contents of a Dictionary such as this, which has been compiled on novel lines. It may be said to consist of proper names which have come to be used as generic words, such as Nimrod; words formed from proper names, as dahlia; "geographical names,

applied only or mainly in trade to exports, or in finance to stocks and shares, such as Demerara (sugar) have been omitted." Of words of non-European origin, borrowed directly from non-European languages, as pasha, sofa, vizier, Zenana. Of Latin and Greek words which retain their original form, as anemone, aroma, epitome, toga; of words borrowed directly from modern European languages, as guerilla, regatta; and of words borrowed from French, Latin, and Greek since the introduction of printing, imperfectly naturalised, and now obsolete.

There is also a small class of coined words to which anti-macassar, and papier-maché belong. The following entry will show what is included in this Dictionary and what is excluded:—

> "Ancient *sb.*, Eng. from It., a rendering of It. *anziano* = 'an elder,' 'a magistrate.' See Anziano. The sb. *ancient*, as a corruption of ensign, is not admissible in this Dictionary."

Besides the words already alluded to there are a large number of phrases which come under most of the above headings; and it will be seen that this volume will form a valuable and useful supplement to the ordinary dictionaries of the language.

Obituary.

EDWARD GRAVES.—Mr. Edward Graves, Engineer-in-Chief of the Telegraph Department of the General Post-office, who died on Wednesday, the 9th inst., was elected a member of the Society of Arts in 1882, and he was also a member of the Electricity Committee appointed by the Royal Commission for the British Section of the Chicago Exhibition. Mr. Graves was born in February, 1834. He commenced his connection with the Post-office in 1870, when the telegraphs were transferred to the State, and was appointed Engineer-in-Chief on the retirement of Mr. R. S. Culley in 1878. He held the office of President of the Institution of Electrical Engineers in 1888.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

NOVEMBER 30.—"The Copper Resources of the United States." By JAMES DOUGLAS. SIR I. LOWTHIAN BELL, Bart., will preside.

DECEMBER 7.—"The Chicago Exhibition, 1893." By JAMES DREDGE. SIR PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., will preside.

DECEMBER 14.—"The Utilisation of Niagara." By PROF. GEORGE FORBES, F.R.S. SIR RICHARD WEBSTER, Q.C., M.P., will preside.

Papers for meetings after Christmas:—

"Transatlantic Steamships." By PROF. FRANCIS ELGAR, LL.D.

"The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air." By PROF. FRANK CLOWES, D.Sc.

"The Purification of the Air Supply to Public Buildings and Dwellings." By WILLIAM KEY.

"Pottery Glazes: their Classification and Decorative Value in Ceramic Design." By WILTON P. RIX.

"On some Points in the Chemical Technology of Oil Boiling, with an account of a New Process for Preparing Drying Oils, for Decorators' and Artists' use." By PROF. W. NOEL HARTLEY, F.R.S.

"The Mining Industries of South Africa." By BENNETT H. BROUGH.

"Ten Years of Progress in India." By SIR WILLIAM WILSON HUNTER, K.C.S.I., C.I.E., LL.D.

"Australasia as a Field for Anglo-Indian Colonisation." By SIR EDWARD N. C. BRADDON, K.C.M.G., Agent-General for Tasmania.

"Indian Manufactures." By SIR JULAND DANVERS, K.C.S.I., late Public Works Secretary, India-office.

"Caste and Occupation at the last Census of India." By JERVOISE ATHELSTANE BAINES, I.C.S., Imperial Census Commissioner for India.

"Mexico, Past and Present." By EDWARD J. HOWELL.

"Newfoundland." By CECIL FANE.

"New Zealand." By W. B. PERCIVAL, Agent-General for New Zealand.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday Afternoons, at Half-past Four o'clock:—

January 19; February 16; March 9; April 6, 27; May 11.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four or Eight o'clock:—

January 17; February 28; March 21; April 2, 16.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 24; February 7, 21; March 14; April 11; May 9.

Cantor Lectures.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock :—

Prof. Vivian Lewes, "The Generation of Light from Coal Gas." Four Lectures.

Lecture II.—November 28.—The researches of Frankland, Stein, Heumann, Soret, and Burch—The chemical changes taking place in a luminous flame.

Lecture III.—December 5.—Theories of luminosity as they at present exist—The genesis of the gas burner—Flat flames, argands, regenerative and incandescent burners—The gas burner in relation to the gas to be burned.

Lecture IV.—December 12.—The effect of the constituents of the atmosphere on the light emitted by flames—The probable limit of light to be obtained from gas—The measurement of light.

Dr. J. A. Fleming, "The Practical Measurement of Alternating Electric Currents." Four Lectures.

January 30; February 6, 13, 20.

Prof. W. Chandler Roberts-Austen, C.B., F.R.S., "Alloys." Three Lectures.

March 6, 13, 20.

Lewis Foreman Day, "Some Masters of Ornament." Four Lectures.

April 10, 17, 24; May 1.

C. Harrison Townsend, F.R.I.B.A., "The History and Practice of Mosaics." Two Lectures.

May 8, 15.

Howard Lectures.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday Evenings, at Eight o'clock:—

Prof. W. Cawthorne Unwin, F.R.S., "The Development and Transmission of Power from Central Stations."

January 13, 20, 27; February 3, 10, 17.

Juvenile Lectures.

Two lectures, suitable for a juvenile audience, will be delivered on Wednesday evenings, January 4 and 11, 1893, at 7 p.m.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "The Generation of Light from Coal Gas." (Lecture II.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Dr. Stevenson Macadam, "Explosions in Flour Mills." 2. Mr. John Davidson, "An Automatic Memorandum Clock."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Joseph Thomson, "To Lake Bangweolo and the Unexplored Region of British Central Africa."

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. B. Bowdler Sharpe, "Curiosities of Bird Life."

Tuesday, Nov. 29...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. John Rigby, "The Manufacture of Small Arms."

Wednesday, Nov. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. James Douglas, "The Copper Resources of the United States."

Royal, Burlington-house, W., 4 p.m. Annual Meeting.

Thursday, Dec. 1...Linnean, Burlington-house, W., 8 p.m. 1. Mr. J. H. Harts, "Notes on Œcodoma cephalotes and the Fungi it cultivates." 2. Prof. F. Jeffrey Bell, on "A Small Collection of Crinoids from the Sahul Bank, N. Australia." 3. Mr. E. A. Smith, "Descriptions of Twenty-six new Species of Land-shells from Borneo."

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Mr. J. Norman Collie, "On the Formation of Orcinol and other Condensation Products from Dehydracetic Acid." 2. Mr. W. W. Fisher, "Isolation of Two Predicted Hydrates of Nitric Acid and Anhydrous Oxalic Acid." 3. Mr. W. N. Hartley, "Observation on the Origin of Colour and of Fluorescence." 4. Dr. H. E. Armstrong, "The Origin of Colours—Azobenzine." 5. Dr. Kipping, "The Reduction Products of $\alpha\alpha'$ Dimethyl $\alpha\alpha'$ Diacetylpentane." 6. Drs. Armstrong and Kipping, "The Products of the Action of Sulphuric Acid on Camphor." 7. Mr. W. N. Hartley, "Methods of Showing the Spectra of Easily Volatile Metals and their Salts, and of separating their Spectra from those of the Alkaline Earths."

London Institution, Finsbury-circus, E.C., 6 p.m. Professor C. V. Boys, "Photographs of Flying Bullets."

Friday, Dec. 2...Geologist's Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,089. Vol. XLI.

FRIDAY, DECEMBER 2, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Prof. Vivian Lewes delivered the second lecture of his course on the "Generation of Light from Coal Gas" on Monday evening, 28th November.

The lectures will be printed in the *Journal* during the Christmas recess.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 30th November. Present: Sir Richard Webster, Q.C., M.P., Chairman; Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., M.D., Alfred Carpmael, Michael Carteighe, Sir George Hayter Chubb, Lord Alfred S. Churchill, Francis Cobb, Sir Phillip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Prof. James Dewar, M.A., F.R.S., Major-General J. F. D. Donnelly, C.B., Sir Henry Doulton, James Dredge, F. Elgar, LL.D., Walter H. Harris, C. Malcolm Kennedy, C.B., John O'Connor, Prof. W. Chandler Roberts-Austen, C.B., F.R.S., Sir Owen Roberts, M.A., Sir Albert K. Rollit, LL.D., M.P., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Tuesday, 29th November. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, Lord Alfred S. Churchill, Francis Cobb, Sir Philip Cunliffie-Owen, K.C.B., K.C.M.G., C.I.E., Sir Henry Doulton, John O'Connor, C. M. Kennedy, C.B., Sir Owen Roberts, M.A., D.C.L., F.S.A., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

Proceedings of the Society.

THIRD ORDINARY MEETING.

Wednesday, Nov. 30th, 1892; Sir Isaac Lowthian Bell, Bart, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Evens, Richard Underhay, 43, Baker-street, W.
FitzGerald, Colonel Charles John Oswald, C.B., Dunmore, Eastbourne.
Foster, Frank, Adelphi-chambers, 7, John-street, W.C.
Gaikwad, Shrimant Sampatrao K., National Liberal Club, S.W.
Joy, David, 17, Victoria-street, S.W., and Manor-road-house, Beckenham.
Roechling, Herman Alfred, 23, Highfield-street, Leicester.
Snowden, Frederick, Aberglaslyn, Amherst-park, Stamford-hill, N.
Voelcker, J. Augustus, 20, Upper Phillimore-gardens, W.

The following candidates were balloted for and duly elected members of the Society:—

Allen, George William, C.I.E., 179, Queen's-gate, S.W.
Anderson, John, junior, Atlantic Mills, Bridgeton, Glasgow.
Ascough, Jesse, Patent Borax Co., Ledsam-street, Ladywood, Birmingham.
Ash, Henry Claudius, Ovingdean, High-road, Brondesbury, N.W.
Baker, William, 1, Chetwynd-road, Lawrence-road, Southsea.
Bantock, George Granville, M.D., F.R.C.S., 12, Granville-place, Portman-square, W.
Barclay, Sir Colville, Bart., C.M.G., 11, Rue François Ier, Paris.
Barnes, S. J., Mayfield, Moseley Wake-green, near Birmingham.
Barrett, Robert, 2, Pembroke-gardens, Kensington, W.
Beare, Prof. Thomas Hudson, University College, Gower-street, W.C.
Beeton, Henry Coppinger, 2, Adamson-road, South Hampstead, N.W.

Beevor, Septimus Felix, B.A., 25, Leinster-square, W.
Bousfield, Charles Edward, St. Mary's-mount, Leeds.
Broad, Clement Burgess, Stamford Brook-lodge, Ravenscourt-park, W.
Bruce, Benjamin John Elder, Town-hall, Hull.
Chapman, Henry Alfred, 235, High-street, Swansea.
Cheswright, Charles, The Homestead, Anson-road, N.
Chutter, George F. Buckingham-street, Birmingham.
Clemson, Walter J., M.A., Taunton, Mass, U.S.A.
Colbron, Joseph Parkin, 2, Osborne-street, Hove, Brighton.
Constantine, Ezekiel Grayson, 32, Victoria-street, Manchester.
Crawter, Frank Whinfield, 35, St. George's-square, Regent's-park, N.W.
Cripps, Charles Alfred, Q.C., 32, Elm-park-gardens, S.W.
Crosse, Hammond William, Deodar-road, Putney, S.W.
Cunningham, Lieut.-Col. Allan J. C., 19, Palace-gardens-terrace, Kensington, W.
Davis, Henry W. B., R.A., 18, St. John's-wood-road, N.W., and Glaslyn, Rhayader, Radnorshire.
Day, Lewis Foreman, 13, Mecklenburgh-square, W.C.
De Morgan, William, 1, The Vale, Kings-road, Chelsea, S.W.
Ede, Francis Joseph, Silchar, Cachar, India.
Ellis, Herbert Moates, Inglesham, Crescent-road, Wimbledon, Surrey.
Estall, George, Lillie-bridge Works, West Brompton, S.W.
Farden, Richard S., 29, Milk-street, E.C.
Farren, George, J.P., Trefani, Carnarvon, and Reform Club, S.W.
FitzGerald, Augustus Edward, Athenæum, Manchester.
Fleming, Ernest Laremont, 11, Bold-street, Warrington.
Gooday, John Francis Sykes, 4, Furnival's-inn, E.C.
Gourlay, Henry, 61, Queen's-gate, S.W.
Gray, George Godfrey, LL.D., J.P., 33, Wellington-square, Hastings, and 19, Old-square, Lincoln's-inn, W.C.
Gray, Thomas L., Rokesley-house, 23, St. Michael's-road, Stockwell, S.W.
Gross, William, B.A., 49, Upper Gloucester-place, Dorset-square, N.W.
Hamerton, George A., M.D., 3, Southampton-street, Covent-garden, W.C.
Harris, Richard, 3, Vinery-villas, Regent's-park, N.W.
Harvey, Edward Arthur, 26, Victoria-square, Clifton, Bristol, and Junior Carlton Club, S.W.
Hawksley, Thomas, M.D., Beowands, Chertsey, Surrey.
Hedley, John Hunt, 55, John-street, Sunderland.
Hehir, Surgeon Captain Patrick, M.D., Hyderabad, Deccan, India.
Henderson, Alexander, 52, Princes-gate, S.W.
Hepper, John, Clareville, Headingley, Leeds.
Hodges, George H., J.P., Oadby Frith, Leicester.
Holmes, Charles, St. Helen's, Dennington-park-road, West Hampstead, N.W.
Howe, George, 41, Wigmore-street, W.
Howell, Edward, Yeovil, Somerset.
Hughes, Herbert William, Priory Farm house, Dudley.
Ingram, William James, 108, Beckenham-road, Penge, S.E.
Ives, Frederic E., Philadelphia, Pa , U.S.A.
Lamb, John Cameron, C.M.G., 4, Vanbrugh-hill, Blackheath, S.E.
Liechtenstein, His Highness John, Prince of, Feldsberg, Austria.
Lloyd, Herbert Gore, 6, West Kensington-gardens, W.
McFarlane, William, care of William Dunn and Co , 43, Broad-street Avenue, E.C., and Cedar Lea, Bournemouth.
Margary, Peter John, Tavistock Hotel, Covent-garden, W.C.
Mitchell, Joseph, J.P., Bolton-hall, near Rotherham.
Mond, Robert Ludwig, M.A., The Poplars, 20, Avenue-road, N.W.
Morris, David, Manora, Karachi, India.
Morris, James, 1, Dalal-street, Bombay, India.
Murton, Charles Augustus, 6 Vanbrugh-park-road West, Blackheath, S.E.
Newman, George, Billiter-street, E.C.
Notley, Richard A., 80, Cornhill, E.C.
O'Callaghan, Francis Langford, C.S.I., C.I.E., United Service Club, Simla, India.
Page, Major S. Flood, 102, St. George's-square, S.W.
Peter, Thurstan C., Redruth.
Pontifex, Sir Charles, K.C.I.E., 5, Wetherby-gardens, South Kensington, S.W.
Poore, George Vivian, M.D., F.R.C.P., 30, Wimpole-street, W.
Portal, Lieut. Bertram Percy, 17th Lancers, Malshanger, Basingstoke, Hants.
Portal, Spencer John, Bere-hill, Whitchurch, Hants.
Potter, Thomas Wickford, Budby Castle, Edwinstowe, Newark.
Powell. Alfred Ernest, 478, Stockport road, Longsight, Manchester.
Press, William James, Burnham, Somerset.
Preston, F. J., Bhusawal, Khandeish, Bombay, India.
Prigg, Henry Victor, Borough Engineer's Department, Plymouth.
Purveez, N. M., care of J. Lyon and Co., 4, Lombard-court, E.C.
Rabbits, William Thomas, 6, Cadogan-gardens, S.W.
Roberts, Emmanuel, M.D., Rakwana, Ceylon.
Robinson, Mark, Chatley, Fassett-road, Surbiton, and Picton-house, Thames Ditton, Surrey.

Sachs, Edwin O., 26, Marlborough-hill, N.W.
Shaw, Peter, 98, Church-street, Fulham-road, S.W.
Simpson, William John, M.D., 16, Theatre-road, Calcutta, India.
Smith, Henry, 8, John-street, Adelphi, W.C.
Smith, Swire, Lowfield, Keighley, Yorks.
Tanner, Slingsby, 104B, Mount-street, Berkeley-square, W.
Tarn, Arthur Windham, 55, Torbay-road, Brondesbury, N.W.
Thomas, William, Penelvan, Camborne.
Thomas, William Brodrick, 52, Wimpole-street, W.
Todd, Hugh Armstrong, 59, Weymouth-street, Portland-place, W.
Townsend, Charles, M.P., St. Mary's, Stoke Bishop, Gloucestershire.
Townsend, Edward, 14, Harold-road, N.
Valon, William A., Hardres-street, Ramsgate.
Wade, James L., 28, West Kensington-gardens, W.
Walker, Charles Robert, 15, Great George-street, S.W.
Waring, Francis John, Nanu Oya, Ceylon.
West, Sir Raymond, K.C.I.E., Chesterfield, College-road, Norwood, S.E.
White, John Isawoo, M.A., Township-office, Pyinmana, Upper Burma.

The CHAIRMAN, in introducing Mr. Douglas, said that he had the pleasure of making his acquaintance nearly twenty years ago when visiting the United States. At that time Mr. Douglas was engaged in carrying out a very ingenious and elaborate mode of obtaining copper, the invention of his late friend Dr. Sterry Hunt. That was conducted by Mr. Douglas for some years with considerable success, but a change in the value of the materials employed, and other circumstances, rendered it impossible to continue that comparatively simple process. Since that time Mr. Douglas had been engaged in very extensive copper enterprises, and he had at present under his direction establishments representing the second largest company in the United States; and he need not remind the members of the Society that the United States stood in the first rank as a producer, not only of the metal with which he (the Chairman) was more particularly connected, but also of copper.

The paper read was—

THE COPPER RESOURCES OF THE UNITED STATES.

By James Douglas.

The growth of the copper production of the United States affords an apt illustration of the speed with which industrial enterprises develop, under the combined influences of great natural resources, of modern machinery used with intelligence and skill, and of a system of liberal land and mining laws, which stimulate to the utmost individual initiative and industry. But, of course, the first condition necessary is the existence of the raw material, in the form of copper ore; and this the United States possesses in quantity which has enabled it to rise rapidly to the position of not only the largest producer, but of the largest exporter, among the mining communities of the world.

To describe briefly the locality of the several groups of its large copper mines, the character of the ore, and the local conditions which influence production, is my task.

Each of the main geographical subdivisions of the United States possesses a distinct group of copper deposits.

The Appalachian chain of mountains, which skirts the Atlantic coast, carries throughout its entire extent, from far beyond the northern limits of the United States to near the Gulf of Mexico, copper, which is chiefly, but not exclusively, contained in masses of iron pyrites embedded in crystalline slates. Copper mines were worked before the Revolution in Connecticut, New Jersey, and Pennsylvania; and the crude ore, of necessity, in obedience to the laws of trade, exported to this country. More recently mines have been worked in nearly all the eastern, middle, and southern States from Maine to Alabama, but most extensively in Vermont and Tennessee. Vermont in 1880 produced from the Ely Mine over 3,000,000 lbs. of metallic copper, but since that date till recently that State has not appeared as a large contributor in the annual statistics. Tennessee, from the Ducktown Mines, was, from 1846 till the breaking out of the War of Secession, the largest producer on the continent, but her mines have been closed for many years. In the States adjacent to Tennessee, in Virginia and North Carolina, Georgia and Alabama, there exist large deposits of iron pyrites, but in the largest copper-bearing mines the pyrites exists as pyrrhotite, and is, therefore, not in favour with the acid makers, while the copper is not of high grade. The statistics of 1891 assign only 1,300,000 lbs. of copper to the Eastern and Southern States. It is probable that they will, in the future, acquire a more prominent position, though, so far as we know, they contain no masses of ore of size and richness sufficient to make their production really important.

From the great trough between the Appalachian and Rocky Mountain chains, drained by the great lakes and the Mississippi, but little copper has been extracted except from the State of Michigan. A sulphuretted ore has been worked at Geneviève, Missouri, on the Mississippi River. Copper exists in Arkansas;

and through north-western Texas run beds of sandstone, probably of Permian age, impregnated more or less with copper glance, but which have not as yet been profitably worked. Within this zone, therefore, of the United States our attention may be confined to what are known as the copper-bearing beds of the Keweenaw series. These consist of beds of trap sandstone and conglomerate of doubtful age.* They rise at a steep angle of about 45° out of the horizontal sandstone from which the basin of Lake Superior has been in great measure eroded. They have but a limited development on the north shore of Lake Superior, where they are being explored for copper in Michipocotan Island. They form the island of Isle Royale, where much mining has been done and little profit made; and they constitute the backbone of the Keweenaw promontory, which protudes far into Lake Superior from the south shore. Beyond Michigan the same series of rocks stretches through Wisconsin into Minnesota, but in Michigan alone have they yielded copper in profitable quantities, though elsewhere throughout their whole extent copper is found as one of their associated minerals. Everywhere in Michigan the copper of the Keweenaw series exists exclusively in the metallic state, but in Minnesota I have seen sulphurets with native copper in conglomerate.

Three classes of deposits have been worked on the Keweenaw promontory. *First*, veins which in some instances cut, and in others are parallel with, the beds, but which are filled by vein-stone different from the intersected rocks. It is these veins which yielded those extraordinary masses, stray blocks of which were reverenced by the Indians, which attracted the attention of the Jesuit Fathers, and which have since appealed so vividly to the popular fancy. *Secondly*, copper-bearing beds of amygdaloidal diabase, locally called *ash beds* and amygdaloidal traps. *Thirdly*, beds of conglomerate, of which the cementing material consists in part of copper.

The first announcement to Europe of the existence of native copper on Lake Superior was made by the Jesuit Fathers in 1659. Père Alouez described in 1666 a stray mass on Ontonagon River; but long prior to that date the Indians had mined the native copper, and fashioned it into ornaments and weapons. After the conquest of Canada, and prior to the Revolutionary War, Alexander Henry organised a company in this country, with the Duke of Gloucester, Charles Townshend, and other men of note as incorporators, to extract and export the native copper ores of Lake Superior. After two years of unsuccessful existence, the company was extinguished by the sale for its debts of the first cargo of native copper ore which reached this country. It has always seemed to me that Mr. Townshend's unfortunate private venture may have embittered his feelings towards North America, and been an indirect incentive to his unpopular financial

* The following letter by the late Dr. T. Sterry Hunt, written in 1874, is interesting in this connection :—

"DEAR DOUGLAS,—Having read with pleasure your article in the *Quarterly Journal of Science*, on 'The Native Copper Mines of Lake Superior,' I venture to offer you some remarks on their geological relations, founded chiefly on my studies in that region in 1872. There has been much difference of opinion as to the age of the great copper-bearing formations of Lake Superior. At an early day it was, on lithogical grounds, regarded as mesozoic, but recent observations clearly show that the cuperiferous series of the Keweenaw Peninsula, consisting of sandstones, conglomerates, and trappean rocks, is unconformably overlaid by horizontal sandstones, which support, in their turn, limestones holding the organic remains of the Trenton Group (Upper Cambrian). According to Brookes and Pumpelly, no difference in altitude is perceived between this copper-bearing series, which may be distinguished as the Keweenaw Group, and the crystalline schists of the Huronians which underlie it. It is, however, to be noted that the red-feldspar porphyry, the pebbles of which make up the conglomerate bed of the Calumet and Hecla Mine, is apparently identical with the porphyry which, along our Eastern shores, appear to constitute a member of the Huronian series. There was, I conceive, a wide interval of time between the Huronians and the Keweenaw Group; and the copper of the latter was probably derived from the solutions formed by oxydation of the cuperiferous sulphurets, which everywhere abound in the Huronian. The horizontal sandstones of the Keweenaw Peninsula and those of Sault St. Marie are doubtless identical. It is in the vicinity of Thunder Bay, on the northern shore of the lake, that are seen the strata which Sir W. Logan made the types of his *upper copper-bearing series*. What he called the *upper division* of his series consists of red and white sandstones, with marls and limestones, which rest, as may be seen, near Silver Islet, in slight unconformity upon the *lower division*, made up of dark greyish or blackish argilites and sandstones. These in Thunder Bay rest directly upon the crystalline schists of the Huronians, and are traversed both by diorite dykes and a series of silver-bearing lodes posterior to the dykes, and extending into the Huronians. This *lower division*, which is not known further eastward, nor in the Keweenaw Peninsula, I have elsewhere called the *Animikie Group*, from the Indian name of Thunder Bay, while the red sandstones and marls I have called the *Nipigon Group* (a term originally proposed by Professor Bell, to include both this and the Animitric Group). These two groups, which constitute together the typical upper copper-bearing series of Logan, are, by Macfarlane and Bell, considered to be mesozoic, and the question arises as to their relation to the two series of uncrystalline rocks of the Keweenaw region. Are the red sandstones of the Nipigon Group the equivalents of the horizontal sandstones of the Portage Lake and Sault St. Marie? or do they correspond to the more ancient sandstones, which are interstratified with the copper-bearing Keweenaw Group? I have elsewhere expressed the opinion, that they are probably distinct from and newer than either of these.—Faithfully yours, T. STERRY HUNT.

"oston, August, 1874."

policy, which precipitated the Revolutionary War. Michigan did not pass into the possession of the United States till 1796, and nearly half a century more elapsed before it became a self-governing State, and the Indians' titles to the land were extinguished Then mining commenced in earnest. The first mines which were extensively and successfully worked were the Cliff and Minnesota. These and a host of less important were opened on the transverse veins of Keweenaw county, near the point of the promontory, and on the bedded veins of Ontonagon county, and attracted investments in some instances by the profits they yielded, and in all by the hope of finding such masses of native copper as were frequently found in the upper levels of the Cliff and Minnesota. The only mass mine working to-day is the Central, and from its lower levels no large masses have been extracted, for as was the case in all the veins without exception, the masses grew fewer and the vein poorer as depth was attainted. The distribution of the masses through the veins was everywhere so irregular that no rule of search could be followed. The largest mass found in the Minnesota Mine was about 500 tons in weight, but from the Central mine was extracted one of 600 tons, to which were attached, by distinct metallic feeders, minor masses of about the same aggregate weight, thus making the total weight of this mass and its branches 1,200 tons. These huge masses, which filled the vein and protruded sometimes into the walls, were cut by chisels into blocks of about 10 tons before being hoisted, and were smelted in special refineries with a movable roof. But though a large mass, when found, would often prove a treasure-trove, the occurrence of masses in the Central, for instance, has always been so rare that the average yield of all the ore treated has only been 1·9 per cent. of copper, and of this about one-half has been recovered, as what is called stamp work or concentrates, and one-half only from the masses. The veins have varied from 30 feet in width to a mere seam, and the productive chutes of ore were never many hundred feet in length. In the Central, for instance, below the 900 foot level the pay chute has not averaged 300 feet in length. A mass mine has consequently never been a large producer, and at present all these once famous mines together do not yield 2,000,000 lbs. of copper.

The second group of mines, namely, those on beds of amygdaloidal trap, succeed the mass mines in date of development and in rate of production. In the early days of lake mining it is easy to conceive of the fascination that the mass mines exercised, and that an ore containing a few small and scattered grains of copper was looked upon as worthless. But one of the old companies, the Copper Falls, failing to work its vein profitably, was tempted, in 1851, to make an experiment on rock extracted from a bed of amygdaloidal trap, across which the vein had cut. The experiment proved so far satisfactory that between that date and 1865 a number of companies attacked the copper-bearing portion of the trap beds; of which companies most have succumbed, but several, notably the Quincy, which has absorbed the Franklin and Pewabic, and the south Pewabic, now the Atlantic, have continued to maintain a vigorous existence. The Quincy is situated immediately to the east of Portage Lake, and the Atlantic immediately to the west. They are on different beds of amygdaloidal trap. Both companies publish full reports of their operations, which furnish interesting particulars of the cost of mining and concentrating. The Quincy Mine is opened to a depth of 4,000 feet on the inclination of the bed. In 1891 it produced 10,542,019 lbs. of copper, at a cost for mining, smelting, and transporting, and ordinary repairs, of $652,410 or 6·19 cents, but $311,859 were expended on a new mill, a railroad, and other extraordinary improvements, which, added to the cost of copper, brought it up to 9·14 cts. per pound of ingot in New York. These extraordinary improvement costs will not continue to be incurred in future years. Prior to the era of expansion of plant—that is, say between 1885 and 1888—the cost of mining copper, all expenses included, was about $7\frac{1}{2}$ cents per lb., and that cost will probably be slightly reduced by the improvements just completed. This result is obtained from the treatment of an ore which has yielded on an average, after rough hand sorting, 2 per cent. of metallic copper.

The record of the Atlantic Mine is still more striking. It is opened on the ash bed, the uppermost copper-bearing bed of the series, a bed of amygdaloidal trap of great uniformity in thickness, of unusual softness, and through which the copper is distributed very evenly, though in very small quantities. The cost of mining and crushing is therefore low; and as hand-sorting cannot be advantageously resorted to, machinery as automatic as possible is employed in every operation; which, indeed, is the case throughout the Lake region. The

ore comes from a depth of over 2,000 feet; is concentrated to what is termed mineral of a grade of 73 per cent. before being smelted, and is refined at one operation. The nett yield of the ore is only 13 lb. of copper to each ton of rock stamped, or about 0·65 per cent. About 1,000 tons of rock are handled daily in the mill. The crushing is done by rock-breakers and five heads of steam stamps, worked by cylinders of 18 inches diameter and 26 inches stroke, under a pressure of 100 lbs. of steam. The concentration is effected by 100 jigs, with two sieves and fifteen slime tables. The ore as it comes from the stamps is sized in V separators. Ore, tailings and concentrations, are moved by water, of which 35 to 40 tons are needed per ton of ore treated. The labour engaged consists of 1 superintendent, 10 stamp-feeders, 2 head-runners, 2 mill-runners, 4 firemen, 2 mechanics, 1 blacksmith, 2 carpenters, chiefly employed in repairing the long flue and tail race, 5 labourers and spare hands, 1 sweeper and lamp cleaner, 3 wash bosses, 1 cooper, repairing and heading the barrels in which the mineral or concentrate is shipped to the refinery; in all 52 men or one man to every 19½ tons treated.

The following summary of results I copy from the company's report for 1891:—

Ground broken in openings and slopes	20,591·1	fathoms.
Rock stamped	297,030	tons.
Product of mineral	5,089,700	lbs.
Product of refined copper	3,653,671	,,
Yield of refined copper per cubic fathom of ground broken	177·4	,,
Yield of rock treated, $12\frac{3}{10}$ lbs. copper per ton, or	0·615 per cent.	

			s.	d.
Gross value of product per ton of rock treated	$1·5467	=	6	5

	$ cts.		s.	d.
Cost per ton of mining, selecting and breaking, and all surface expenses, including taxes	0·9529	=	3	11
Cost per ton of transportation to mill	0·0386	=	1	2
Cost per ton of stamping and separating	0·2583	=	1	1
Cost per ton of working expenses at mine	1·2497	=	5	2
Cost per ton of freight, smelting, and marketing product, including New York office expenses	0·1847	=	0	9
Cost per ton of running expenses	1·4344	=	5	11
Total expenditure for ton of rock treated	$1·5451	=	6	5

Such admirable results are largely due to the administrative ability of Mr. Stanton, the General Manager. But it would be a mistake to take the above figures as a criterion of what can be done when treating hard rock, such as is the conglomerate, or even the harder traps. Low as the ore runs in copper, the company made, even in 1891, a mining profit of $35,564·45. The amygdaloid mines, however, if we except the Quincy, do not notably swell the lake production. But there is without doubt, on the amygdaloid beds, large tracts of such low grade ground as that mined by the Atlantic which could be profitably treated were copper to stand permanently at a higher figure. The cost of installation of a large Lake plant is, however, so heavy as to impose caution on sensible investors.

The heavy producers are the conglomerate mines. It was not till 1864 that the Boston and Albany, disappointed by their operations on an amygdaloidal bed, turned their attention to the conglomerate. Their efforts were not rewarded by profits; but they attracted miners to a class of ore disregarded up to that date, and were the forerunners of the Calumet and Hecla, and the Tamarack. Though copper is so widely distributed through the several conglomerate beds of the Keweenaw series as to be almost a constituent of the rocks, and though so many attempts have been made to work them, success has attended the operations on only one long chute of ore, that which is known as the Calumet conglomerate. Elsewhere the conglomerates, though they carry in places a higher per-centage than the richer traps, owing to their great hardness, have defied profitable exploitation. An indication of the limit of per-centage which can safely be relied on as profitable, is afforded by the Osceola, a conglomerate mine on the southern extension of the Calumet, from whose reports for 1891 may be gathered the following particulars:—

The copper produced was 6,543,358 lbs. from an ore which yielded 1·40 per cent.

	$	cts.
The cost per ton of rock hoisted was	1	83
Cost per ton of rock stamped	2	13

	cts.
Copper cost per lb. at the mine	7·63
Cost of smelting, freight, and all other expenses of handling copper	1·64

Making the cost per lb. of refined copper for the year, excluding construction	9·27
Cost per lb. for construction	0·84
Total cost per lb.	10·11

It will be remarked that the cost of mining and crushing the hard conglomerate, even under such excellent management as that of Capt. John Daniell, is much higher than those quoted from the reports of the Atlantic Company working on the soft bed.

Attention was attracted to the Calumet conglomerate by old Indian excavations. Work was commenced in 1865, and the mine rapidly rose to a position of supremacy, which was not challenged for 20 years. In its early days the mill yield was about 5 per cent., as then the ore was not sent to the mill with that indiscriminate impartiality which is practised to-day when the average yield is about 3¼ per cent. of ore, unselected within the mine or at surface. The nett yield of the Tamarack ore, extracted from the same bed, at a lower level, is somewhat below that of Calumet and Hecla, being only 2½ per cent. of metallic copper. This lower grade does not of necessity presage an average declension, owing to greater depth, but may be due to the fact that the Tamarack workings, whose extent as yet is very much more limited than those of the Calumet and Hecla mine, happen to have attacked a poorer section of the bed. The Calumet and Hecla does not publish the same minute statement of its operations as other companies from whose reports I have quoted, but judging from the cost of treatment of the same class of ore by the Osceola and Tamarack companies, and from the character of the rock treated, we know that the cost of treatment of Calumet ore must of necessity be far greater than that, for instance, of any of the amygdaloid companies. The length of productive ground on the Calumet conglomerate as explored along its outcrop on Calumet and Hecla ground, and on Centennial and Osceola property to north and south, is about three miles; and exploration on the dip of the bed has determined the existence of ore to a depth of nearly a mile. Though Calumet and Hecla owns what seems to be the most productive portion of the outcrop, a large area of the bed on its dip is owned by the Tamarack, Tamarack Junior, and other companies and individuals. The Tamarack, encouraged by finding good ground in their first vertical shaft at a vertical depth of 2,270 feet, is sinking in the hope of cutting the vein and finding it profitable at a depth of about 5,000 feet. At present this body of ore is tapped by twelve inclined and three vertical shafts on Calumet and Hecla ground, by five inclined shafts on Centennial, three inclined shafts on Osceola ground, and by two vertical shafts on Tamarack ground. In addition, Tamarack is sinking two very deep shafts on another section of their property, and Tamarack Junior is sinking below the limits of the Centennial Company's property. Doubtless as the ore chute of the Calumet conglomerate is limited along its horizontal extension, there is a limit to profitable ore in depth. If we assume, however, that the depth of the ore chute bears some proportion to its length, we have a body of ore, three miles long by, say, three miles deep, which at present price of copper can be profitably extracted. This alone will maintain the importance of the lake regions as a producer for many a year to come. The treatment of the conglomerate is effected by the same automatic machinery, arranged substantially in the same way as that employed in concentrating the amygdaloidal traps. As the Calumet and Hecla controls its own refineries, it is found more profitable not to run up the concentrates to as high a degree as that aimed at by some of the minor companies, whose mineral is smelted at so much per ton.

With regard to the probable discovery of other large mines upon this same series of copper-bearing rocks, all that can be said, in view of the fact that probably not one company in twenty organised since the incorporation of the Cliff Company in 1844, has paid a legitimate dividend, is that though the copper-bearing rocks in South-western Michigan and in Minnesota are largely developed and are known to carry copper *in situ*, and to yield considerable float copper ore, no profitable mine has yet been opened there, and facility for exploration is reduced by the heavily wooded character of the country, and the prevalence of low swampy ground. It is fair, also to assume that unless copper not only rises to, but maintains itself, at a high figure, new mining operations will not be eagerly engaged in within the present mining district by those best conversant with the risks of Lake mining. At the same time it is consolatory to know that there are within those beds enormous resources of low grade ore, should that metal ever become scarce and valuable.

There are sulphuretted ores of copper in both Michigan and Wisconsin outside of the Keweenaw series, but on none have mines of

notable productiveness been opened. The Lake mines possess the advantage of cheap water transportation to such distributing points as Chicago, Detroit, and Cleveland through the summer months, but they labour under the disadvantage of a frightfully rigorous climate throughout the winter. Abundance of timber, and what is even more essential to their automatic operations, abundance of water, distinguish them from the next group of mines which will claim our attention, viz., those of the Rocky Mountains zone.

Long before railroads gave access to the Rocky Mountains the existence in them of copper in large quantities was known. In fact, copper bars made from oxidized ore in Arizona were hauled as return freights by ox-team, a distance of nearly 700 miles, to the terminus of the nearest railroad; and the richer argentiferous copper ores of Butte Montana were for several years hauled 400 miles to Corinne, the nearest station on the Central Pacific railroad. Extensive operations were, however, forbidden by such costly transportation, and therefore the copper mines of the Rocky Mountains only sprang into prominence when reached by the transcontinental railroads and their branches. In 1880, the Southern Pacific Railroad Company had pushed their Californian system across Arizona, and in the early part of 1881 made connection with the Atcheson and Topeka Railroad at Deeming, New Mexico, thus giving ready access to the mines of Southern Arizona. At the same time the Union Pacific was pushing forward a narrow gauge line from Ogden in Utah to Butte Montana, which reached its destination in the fall of 1881. Thus almost simultaneously the great copper-producing regions in the extreme north of the Rocky Mountain zone and the extreme south were reached, and their resources rendered available. Hence the reason why the production of the United States jumped so rapidly at that period.

In 1879, the total production of copper of the United States was 23,000 tons, in 1880 it rose to 27,000, in 1881 to 32,000, in 1882 to 40,000, in 1883 to 51,000 tons; but the statistics for 1884 show a still more rapid bound to 63,000 tons, which was increased in 1885 to 74,000. This further augmentation was due to the discovery and rapid development of the Anaconda Mine in Butte. Since that date keen rivalry, and possibly a desire or a necessity to endeavour to make a certain aggregate profit, as the profit per ton decreased, by increasing the tonnage treated, has led the larger mines, preeminently the Calumet and Hecla, and the Anaconda, to increase their facilities and their consequent production, with results which have been acutely felt by the markets of Europe as well as of America. As it happens, although twelve years have elapsed since these Rocky Mountain mines were by railroad drawn within the circle of the world's commerce, no large new deposits have been discovered or opened, although the Rocky Mountain system of railroads has in the interval been very widely extended. It has, of course, reached mines which were then known to exist, but excluded from active operation by reason of costly transportation — such, for instance, as the Verdi mines in Central Arizona. But it is a significant fact that, despite the greatly increased facilities, no large copper deposit then unknown has since been discovered and opened.

The Rocky Mountain mines may be subdivided into two groups: those of Southern Arizona, and those of Northern Montana.

The ores heretofore yielded by Southern Arizona have been naturally oxidised, a circumstance which has compensated for their great distance from fuel, and for the absence of silver as a constituent mineral. They are reduced to metal as 96 per cent. bars at one fusion, in water-jacketed cupola furnaces. Nature likewise, in eliminating the sulphur, has purified the ore from certain other obnoxious elements which are commonly associated with copper, and thereby enabled Arizona bars to take a higher rank in the copper market than most copper made from sulphuretted ore. In fact, Arizona copper has heretofore held an intermediate position in value between Lake copper, extracted from ore which nature by her own reduction and refining operations has converted into a metal of almost absolute purity, and copper made from sulphuretted ores by artificial methods; which, rapidly applied, are less effectual in eliminating impurities than are nature's slow and thorough processes.

With insignificant exception, all Arizona copper comes from three groups of deposits: one near Clifton, another at Bisbee, and a third in the neighbourhood of Globe. At Clifton the copper is made by two companies, the Arizona Copper Company, a Scotch organisation, and by the Detroit Copper Company. At Bisbee the Copper Queen Consolidated Mining Company is the only large operator, and at Globe the Old Dominion Copper Company is the only present producer.

The ore occurs in all three districts in, or

adjacent to, carboniferous limestone, which has been chemically and mechanically influential in assisting the oxidation of the ore to a very considerable depth; for, through the crevices which intersect the limestone, and which have, in part, been the result of the ore-decay itself, water has filtered down from the surface, and decomposed the ore to a depth of many hundred feet, and often far below the line of decay of the adjacent feldspathic rocks, unless where these rocks are themselves charged with copper. In Bisbee, the ore-bodies appear to be confined to the limestone, but follow no regular order in their distribution. In Clifton and Globe, on the other hand, the ore-bodies, though of irregular size, and occurring at irregular intervals, are generally found in the plane of contact between the limestone and granite, or the limestone and sandstone. Sometimes, however, and then over considerable areas, the granite and sandstone themselves are replaced by copper and associated ores. But even in these cases, the contiguous limestone has apparently played an essential part in the genesis of the oxidised ore. Sulphuretted ores of copper are found in all of our extensively worked carbonate mines, sometimes in large masses, which from some cause, not always assignable, have escaped decay, occasionally even at a much higher level than that at which oxidised ores occur in the same mine. The average per-centage of copper in the ore it is difficult to determine, since unassorted ore is never delivered to the furnaces, while the grade to which it is selected is dependent in each district upon the cost of fuel and transportation. The furnace-yield of Copper Queen wet ore is about 8 per cent., but almost as much very lean ore is stewed away in the stopes as is delivered to the furnace bins. The average ores of the other carbonate districts are probably richer, and their furnace-yield is notably higher. The deeper Queen ores consist essentially of ferric oxide associated with cuprous oxide and cupric carbonate, resulting from the oxidation of iron and copper pyrites. They are consequently basic. But sufficient siliceous ore can be procured to supply the necessary acid flux for the furnace mixture. In the other districts, on the contrary, where the ore-gangue consists largely of altered granites and sandstones, the siliceous and aluminous constituents have been imperfectly eliminated, and barren limestone must be added to the furnace charge. But in none of the large producing mines does the average of the ore reach the high per-centage promised to investors in the prospectuses of undeveloped south-western mines.

The Arizona ore beds are characterised, as may be inferred from the above description, by great irregularity in size, distribution, and yield. In the Copper Queen Mine a connection between one ore body and another can always be ultimately traced. But large sums are necessarily expended in exploration which often results fruitlessly. When large masses are found, stopes of great size are often opened, and the ore being soft, the actual cost of breaking it is low, but, on the other hand, the expense of replacing all the ore extracted by heavy timbers built in square setts, and the cost of pumping with coal brought from a distance of 700 miles, raise the total cost of mining to a comparatively high figure, for lumber and wages throughout the whole Rocky Mountain zone are much higher than in the fertile and thickly populated States to the east or upon the Pacific coast to the west.* None of the Arizona companies publish precise statements of cost, but all those which are not encumbered by heavy fixed charges are known to have been prosperous of late years, and to have added very largely to their facilities for economical production.

None of the carbonate mines, however, have deemed it judicious to largely increase the production, which they have maintained at a very uniform figure for some years past. The only Arizona mine whose output has been greatly augmented during the past and present year is the United Verdi, a mine discovered and partially opened long before the advent of a railroad to its neighbourhood rendered it possible to work it at all. It remained closed for some years after operations had been commenced, but has recently been resuscitated under vigorous management. In addition to the properties enumerated above, many copper claims have been exploited by public companies, but invariably without financial success. In other sections than those named, as well as in those sections themselves, there exist unquestionably large quantities of copper, but it is either contained in ore too lean to pay at present cost of beneficiation, or it is associated with refractory substances which forbid its treatment by simple and cheap methods of reduction, or it

* Miners' wages in Southern Arizona are from 3 dols. = 12*s.* to 3 dols. 50 cents = 14*s.* per day. In Butte they are 3 dols. 50 cents. per day. Common labour in both localities generally command 2 dols. 50 cents = 10*s.*

is too distant from market. These reserves, however, stand to the developed mines very much in the same relation that the leaner ores of the Keweenaw series stand to those of the great Lake mines. With cheaper methods of treatment, lower freights or a higher price for copper, they may be available in the future, but are not likely to swell the world's production for the present. The total output of Arizona has never exceeded 40,000,000 pounds.

A much more disturbing element has been the great mines of Butte, in Montana. As already explained, Butte came into existence as a producer simultaneously with the mines of Arizona, but instead of maintaining an almost stationary production, the record of the Butte mines has shown an extraordinary augmentation of yield from year to year. For while in 1882 Montana produced only half the copper that Arizona did, viz., 9,000,000 lbs., as against 18,000,000 for Arizona, in 1883 Montana exceeded Arizona, producing 24,600,000, against Arizona's 23,800,000, and since then has, during every year except 1886, recorded so notable an advance in production that the 9,000,000 of 1882 is succeeded by 113,000,000 lbs. in 1891. Most of this large production comes from one bold vein, the most productive portion of which is owned by three exceedingly active and enterprising companies. The vein consists of a granitic filling, impregnated everywhere more or less with mineral, and carrying masses sometimes of 50 and 60 feet in width of rich copper ore, associated always with more or less silver. From east to west, the portion known to be productive exceeds three miles in length. As is the case with every large vein, there are portions where concentration has enriched it, and such a section as this case fell to the lot of the Anaconda Mining Company. While the vein varies in size and richness of copper, it also varies notably in the silver tenor of its ores. Towards the eastern extension, in the Gagnon Mine, the ore is really rather a silver than a copper ore. In the next large property, the Parrott, the silver probaby bears a slightly higher proportion to the copper than it does in the Anaconda and St. Lawrence. West of the Anaconda, in the property owned by the Boston and Montana, there is ore which yields copper with a very profitable amount of silver, but in most of the ore the silver has added heretofore but little to the value of the copper, being probably in about the proportion of half an ounce of silver to the unit of copper.

In places, rich silver and copper ores crop out at surface, but at the culminating point of the lode near the top of the hill, in the Anaconda and Mountain View mines the lode was depleted of its copper to a depth of about 400 feet, leaving above that level an ore which was at one time regarded as a workable silver ore. The copper that had been leached out of this sterile tract was concentrated in a layer of exceptional size and richness which, when reached, enabled the Anaconda, through the rapid shipment of some 25,000 tons of rich ore, to spring almost into the first rank of copper producers. Beneath this layer of secondary ore in all the mines lies an unaltered ore necessarily of a much lower grade than the secondary ore, though carrying, if anything, a higher proportion of silver to copper.

The Anaconda Mining Company makes no official statement. As their workings are much deeper than those of the adjacent property operated by the Boston and Montana Company, it may be assumed that the average of the ore treated runs lower in copper. In addition to the Anaconda and St. Lawrence, situated on the main lode, the Chambers Syndicate, which is a branch of the Anaconda Company, owns a large number of claims on parallel lodes and off-shoots from the main lode. The product from all their mines is conveyed to Anaconda, a distance of thirty-two miles, where an abundant supply of water and an extensive plant allows of the concentration of over 2,000 tons of ore a day. The furnace treatment is effected in two establishments, where ores capable of producing highly auriferous matte are smelted separately from the ores of a lower silver grade. Heretofore the copper has been shipped in the form of matte of 60 to 65 per cent.; but there is at present in process of erection a large Bessemer and electrolytic plant of size sufficient to handle all the matte which the Baltimore Smelting and Refining Company is not prepared to treat. It is expected that this large separating and refining plant will be in full operation next spring, and that, thenceforth, all matte shipments from that source to Europe will cease.

The company, whose capacity for production in Butte follows that of the Anaconda, is the Boston and Montana, which owns the eastern terminal claims of the great lode and a quantity of adjacent property. Their published reports convey the following information with regard to their operations during the year ending June 30th, 1892 :—

Ore treated	151,489 tons.
Product of matte and shipping ore	52,060,355 lbs.
Product of copper............	28,564,826 lbs.
Product of silver	286,820 ozs.
Yield of matte per cubic fathom of ground broken....	5,809 lbs.
Yield of copper per cubic fathom of ground broken....	3,188 lbs.
Yield of copper per ton of ore treated.....................	18,262 lbs.
Per-centage of matte in ore treated.....................	16·64 per cent.
Per-centage of copper in ore treated.....................	9·13 per cent.
Copper in matte, cost per pound at mine	5·91 cts.
Copper in matte, cost per pound of freight, commissions, assaying, weighing, and Boston expense	1·78 cts.
Copper in matte, cost per pound laid down in New York and sold	7·69 cts.*

The area of good ground owned by this company warrants the belief that they will continue for many years to be very large producers of copper and silver. As in the case of the Anaconda, the necessity of separating the gold and silver from their matte, and thus securing the refiners' profit, has induced them to undertake the erection at the Great Falls of the Missouri, over 200 miles distant by railroad, of a very large concentrating, smelting, Bessemerizing, electrolytic, and refining plant. The works there will be propelled by water-power, of which they have under control 2,600 horse-power. The capacity of their concentrator is 600 tons per diem. The calcination of the ore will be effected in twenty-four Bruckner cylinders, and for its fusion into matte there will be used reverberatory furnaces of a tilting type, heated by gas, which will be made from the Sand Coulee coal, mined in the neighbourhood of the Great Falls. A Bessemerizing and electrolytic plant is in course of construction, and, when completed, will be of a capacity to treat the company's total product.

There is a third copper company in Butte, of growing proportions, namely, the Butte and Boston, which appears in the statistics of last year as making 18,134,343 lbs. of copper—a production which it is likely to more than maintain in the future; for, though the company does not own a section of the main lode, it has a large number of very productive claims to the north of the lode, where the copper is usually associated with a higher proportion of silver than is the copper of the main lode itself. The Butte and Boston likewise proposes to convert its matte into metallic copper, and separate the silver by electrolysis.

The operations of the Butte and Boston show a large working profit, which has, however, been entirely absorbed by construction—and, in fact, the construction account of all the large Butte enterprises has been exceptionally heavy, and even when the works, as planned, are completed, will never be closed. But when the money saved by the more economical treatment of the ore in the large works, now in course of construction by the several companies, is added to the silver which will then be recovered, there is little doubt that the financial statements of the Butte companies will make a much more favourable showing than they do at present.

The activity with which mining is prosecuted in the immediate neighbourhood of Butte is best illustrated by the fact that in the Silver Bow district about 5,000 mining claims have been patented, and the mines maintain a population of about 25,000 inhabitants.

Outside Butte no district promises, in the near future, to be a large producer. In Idaho, in the Seven Devils' District, there exist very promising indications of copper wealth, though, till exploited, its extent must be a matter of speculation. Nevada, Utah, and Wyoming have all yielded more or less copper, and all contain ores which, under more favourable conditions than exist to-day, will be utilised. Colorado stands in the list of producers as a State of growing importance. The deeper lead mines of the Leadville district carry in some instances a notable amount of copper, and copper is associated with the silver ores of several of the more southerly districts, and appears as a bye-product in the returns of the lead smelters. Though Colorado does not possess any large mines of copper, properly so-called, her production will increase rather than decrease. New Mexico is not a large producer.

Passing from the Rocky mountain zone to the Pacific coast, California alone has been a notable producer, Oregon and Washington territory having produced only hopes and reports, but no metal. California, as far back as 1864, shipped large quantities of ore, chiefly from the Union and Campo Seco Mines of Calaveras County, which were opened on lenticular masses of sulphuretted ore, imbedded in slate; but, from 1866 till recently, these mines have remained closed. Operations,

* This would seem to be the cost after deducting what was received for silver.

however, have been resumed, and the ore, instead of being shipped, is treated on the spot; and, therefore, California, in the future, will rank again as a producer, though not of a very high rank.

When we review the present position of the copper industry, we are struck by the fact that, though for many years no new mine has been opened, the larger and richer ones, which have been able to maintain existence in the face of depressed prices, are directing their efforts, not so much towards increasing their capacity for production as towards reducing the cost of reduction, saving, as far as possible, the precious metals associated with their ores, and securing for themselves the profits which have heretofore been made by the refining companies, to whom they sold their furnace material. The effect of this change of policy may tell upon the market. It certainly will affect the copper refineries of this country and the continent. It would seem, therefore, that the era of rapid expansion is drawing to its close, and a healthier one of economical treatment is being inaugurated. The demand for copper is so great, that, if this policy be pursued by the large existing mines, there will be room for the appearance of new competitors, without imminent risk of over-production.

While the production of copper, the world over, has gone on with leaps and bounds, the consumption has kept about uniform pace with it. At one time an old special use for the metal, such as for the sheathing of ships, has been abandoned, but at another a new use, such as for electrical transmission, has been created. Meanwhile, the demand for copper and its alloys for domestic purposes, for architectural decoration, and for the construction of machinery, has gone on steadily increasing. If we look back, say till 1850, in the United States, we find the consumption per head to have declined during only one decimal period, due, doubtless, to the revolution between 1850-60 in naval architecture, when iron ships supplanted wooden and copper bottoms. The following table is, at any rate, approximately accurate :—

Year.	Population.	Consumption in Tons of 2000 lbs.	Consumption per Head.
1850	23,191,876	6,710	0·550 lbs.
1860	31,443,321	7,116	0·405 ,,
1870	38,558,371	12,342	0·603 ,,
1880	50,155,703	26,799	1·006 ,,
1890	62,622,250	94,800	3·02 ,,

Here in Great Britain the consumption per head appears to be even higher, for if the difference between imports and exports in 1880 and 1890 represent domestic consumption, the result is as follows :—

British Imports, Exports, and Consumption.

Year.	Imports	Exports	Consumption.	Population.	Consumption per head.
	tons.	tons.	lbs.	1881.	lbs.
1880...	92,734	59,482	33,252	30,066,646	2·477
				1891.	
1890...	141,249	89,747	51,502	37,740,283	3·084

Owing to the greater rate of increase of population in the United States, the increase of consumption there will be more rapid than anywhere on this side of the Atlantic, and therefore compensation will be provided against an increase of production on the North American Continent. The trade, therefore, need not be apprehensive on account of increased average production. What is to be feared is such rapid and spasmodic augmentation as has characterised the past ten years. But, as we have pointed out, that was largely due to the sudden opening up by railways of almost an entire continent known to be rich in minerals. Such extraordinary occurrences do not frequently repeat themselves. Yet, in spite of this, the balance between consumption and production, even in the United States, taken over a series of years, has not been very seriously disturbed, as the following Table seems to demonstrate :—

Year.	Production.	Increase.	Consumption.	Increase.	Exports.
	lbs.	pr. cent.	lbs.	pr. cent.	
1882...	91,819,458		85,574,095		6,245,363
1883...	117,151,795	27.50	96,283,056	12·51	20,868,759
1884...	147,805,407	26·16	87,512,961	—9·11	60,292,446
1885...	170,962,324	15·67	77,812,886	—11·08	93,149,458
1886...	161,263,043	—5·67	94,947,382	22·01	66,315,661
1887...	185,227,331	14·85	116,612,576	22·81	68,614,753
1888...	223,481,588	20.65	119,853,456	2·78	120,742,047
1889...	243,676,000	9·00	169,600,000	41·51	119,485,050
1890...	265,584,000	9·00	189,584,000	11·8	65,088,059
1891...	301,820,000	13·64	216 820,000	14·37	110,000,000
	Average...	14·53		11·95	

There have been great annual variations, but the average annual increase in production of 14·53 per cent., and the average annual increase of consumption by 11·95 per cent., probably fairly express the growth of the trade in that country.

In speculating on the course of the copper trade, a peculiarity which should give stability to its movements must not be lost sight of, viz., that a comparatively small number of

corporations produce the major part of the world's production. In the following Table the production of the Anaconda Mine for 1890 has been introduced instead of that for 1891, when it was closed for seven months.

TABLE SHOWING THE PRODUCTION OF EACH OF THE PRINCIPAL COPPER MINES OF THE WORLD IN 1891, AND THE PERCENTAGE OF THE WHOLE MADE BY EACH OF THE LARGE PRODUCERS.

	Tons of 2,240lbs.	Per-centage	Per cent.	Per cent.
United States	141,162	48·25		
Foreign	151,365	51·75		
World	292,527	100·		
Rio Tinto	32,000	10·94	10·94	10·94
Tharsis	10,500	3·59	3·59	3·59
Mason and Barry	4,150	1·42	1·42	—
Cape Copper	5,000	1·71	1·71	1·71
New Quebrada	6,500	2·22	2·22	2·22
Chili	19,875	6·79	—	—
Mansfeld	14,250	4·87	4·87	4·87
Japan	17,000	5·81	—	—
Australia	7,500	2·56	—	—
Boleo	4,100	1·40	1·40	—
Calumet and Hecla	29,018	9·92	9·92	9·92
Quincy and Franklin	6,497	2·22	2·22	2·22
Tamarack	7,231	2·47	10·31	10·31
Osceola	2,869	·98		
Boston and Montana	11,958	4·09		
Butte and Boston	8,095	2·77		
Anaconda	28,600	9·78	9·78	9·68
Parrott	6,405	2·18	2·18	—
Old Dominion	3,138	1·07	1·07	—
Arizona Copper Company	3,000	1·03	1·03	—
United Verde	2,942	1·01	1·01	—
Copper Queen	4,480	1·53	2·59	2·59
Holbrook and Cave	1,218	·42		
Detroit	1·72	·64		
Other United States	24,694	8·44	—	—
Other Foreign	29,635	10·14	—	—
Total	292,527	100·	66·26*	58·15†

* Produced by 16 companies. † Produced by 10 companies.

Grouping together the Tamarack, Osceola, Boston and Montana, and Butte and Boston, which are controlled by the same shareholders, and the Copper Queen, Holbrook and Cave and Detroit, which are managed from the same office, it would appear that ten companies make 58·15 per cent. of the world's supply, and sixteen companies make 66·26 per cent. If we confine our view to the copper mines of the United States, we find that 37 per cent. of the world's produce is made by six American companies, or groups of companies.* The copper trade, therefore, in the United States, as elsewhere, has not escaped the universal tendency towards consolidation of capital in certain directions under a single management. In the case of the copper mining industry, the result has been brought about naturally and spontaneously.

* See *Engineering and Mining Journal*, July 23, 1892.

APPENDIX.

TABLE I.—COPPER-PRODUCT OF THE UNITED STATES FROM 1845 TO 1891, SHOWING RELATIVE PROPORTION OF THE LAKE SUPERIOR PRODUCT.

[From "Mineral Resources of the United States," to 1890, published by the U.S. Geological Survey.]

Year.	Total product.	Lake Superior.	Calumet and Hecla.	Per-centage of L. Superior of total product.
	Long tons.	Long tons.	Long tons.	
1845	100	12	—	12·0
1846	150	26	—	17·0
1847	300	213	—	71·0
1848	500	461	—	92·5
1849	700	672	—	96·0
1850	650	572	—	88·0
1851	900	779	—	86·6
1852	1,100	792	—	72·0
1853	2,000	1,297	—	64·9
1854	2,250	1,819	—	71·1
1855	3,000	2,593	—	86·4
1856	4,000	3,666	—	91·6
1857	4,800	4,255	—	88·7
1858	5,500	4,088	—	74·3
1859	6,300	3,985	—	63·3
1860	7,200	5,388	—	74·8
1861	7,500	6,713	—	89·1
1862	9,000	6,065	—	67·4
1863	8,500	5,797	—	67·0
1864	8,000	5,576	—	69·7
1865	8,500	6,410	—	75·4
1866	8,900	6,138	—	68·8
1867	10,000	7,824	603	78·2
1868	11,600	9,346	2,276	80·6
1869	12,500	11 886	5,497	95·1
1870	12,600	10,992	6,277	87·2
1871	13,000	11,942	7,242	91·9
1872	12,500	10,961	7,215	95·7
1873	15,500	13,433	8,414	87·3
1874	17,500	15,327	8,984	87·6
1875	18,000	16,089	9.585	89·4
1876	19,000	17,085	9,683	88·9
1877	21,000	17,422	10,075	82·9
1878	21,500	17,719	11,272	82·4
1879	23,000	19,129	11,728	83·2
1880	27,000	22,204	14,140	82·2
1881	32,000	24,363	14,000	76·1
1882	40,467	25,439	14,309	62·1
1883	51,574	26,653	14,788	50·1
1884	63,555	30,916	17,812	48·4
1885	74,053	32,206	21,093	43·5
1886	69,971	35,666	25,259	50·1
1887	80,768	33,693	20,543	41·7
1888	103,245	38,604	22.453	38·2
1889	100,918	39,043	21,727	38·7
1890	115,669	44,976	26,727	38·9
*1891	128,179	51,505	28,880	40·1

* From *Engineering and Mining Journal.*

TABLE II.—COPPER-PRODUCT OF THE UNITED STATES, BY STATES AND TERRITORIES.

[Complied from *Engineering* and *Mining Journal.*]

	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	Percentage of Product
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Michigan (Lake Superior.)	57,155,991	59,702,404	69,353,202	72,147,889	79,918,460	76,028,697	86,587,424	87,504,103	99,570,000	115,390,000	40·0
Arizona	17,984,415	23,874,963	26,734,345	22,706,366	16,000,000	17,790,000	33,200,000	32,933,000	35,720,000	39,700,000	13·8
Montana	9,058,284	24,664,346	43,093,054	67,798,864	57,611,485	78,699,677	98,500,000	104,539,353	111,010,000	113,200,000	39·4
New Mexico	869,489	823,511	59,450	79,839	558,385	283,664	1,631,271	3,400,000	870,000	1,600,000	
California	826,695	1,600,862	876,166	495,028	430,210	1,600,000	1,570,021	1,700,000	2,140,000	3,750,000	
Colorado	1,494,000	1,152,652	2,013,125	1,146,460	409,306	2,012,027	1,621,100	3,100,000	6,760,000	7,000,000	
Utah	605,880	341,885	265,526	166,199	500,000	2,500,000	2,131,047	2,400,000	600,000	1,700,000	6·5
Wyoming	100,000	962,468	—	—	—	—					
Nevada	350,000	288,077	100,000	8,871	50,000	—					
Idaho	—	—	46,667	40,381	—	—					
Middle States	294,695	324,706	232,114	190,000	—	—	3,240,725	3,000,000	3,900,000	4,800,000	
New England States	1,555,000	612,124	904,423	211,602	315,719	200,000					
Southern States ..	400,000	395,175	317,711	40,199	29,811	—					
Lead refiners	125,000	782,880	950,870	910,144	1,282,495	2,432,804					
Domestic product	90,819,449	115,526,053	144,946,653	165,942,842	157,105,872	181,546,869	228,481,588	238,576,456	260,570,000	287,120,000	99·7 per ct.
Imported ores	1,000,000	1,625,742	2,858,754	6,056,841	4,500,000	3,750,000	5,100,000	5,000,000	6,100,000	11,500,000	
Total product....	91,819,449	117,151,795	147,805,407	171,999,683	161,605,872	185,296,869	233,481,588	243,676,456	266,670,000	298,620,000	

TABLE III.—COPPER PRODUCT OF LAKE SUPERIOR.

(Compiled from *Engineering and Mining Journal.*)

Name of Mine.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Calumet and Hecla.........	32,053,539	33,125,045	40,473,585	47,247,990	50,518,222	46,016,123	50,295,720	48,640,029	59,000,000	65,000,000
Quincy	5,665,796	6,012,239	5,650,436	5,848,530	5,888,517	5,603,691	6,367,809	6,405,686	8,050,000	10,300,000
Osceola............	4,176,782	4,256,409	4,247,630	1,945,208	3,560,786	3,574,972	4,134,320	4,534,127	5,196,950	6,426,740
Franklin	3,264,120	3,488,708	3,748,652	4,007,105	4,264,297	3,915,838	3,655,751	4,336,000	5,368,506	4,253,575
Allouez	1,683,557	1,751,377	1,928,174	2,170,476	1,725,463	885,010	314,198	1,762,816	1,417,306	1,227,000
Atlantic	2,631,708	2,682,197	3,163,585	3,582,633	3,503,670	3,641,865	3,974,972	3,698,837	3,644,403	3,648,000
Pewbaic	1,482,666	1,171,847	227,834	—	—	—	—	—	—	—
Central	1,353,597	1,268,556	1,446,747	2,157,408	2,512,886	2,199,133	1,817,023	1,270,592	1,366,011	1,329,000
Grand Portage .	757,080	735,598	255,850	—	—	—	—	—	—	—
Conglomerate...	734,249	222,117	1,198,691	—	—	—	—	—	—	—
Mass	737,440	659,474	481,396	633,500	247,179	—	71,090	76,775	61,500	30,114
Copper Falls ..	587,500	804.000	891,168	1,150,538	1,378,679	719,150	1,199,950	720,000	650,000	1,460,000
Phœnix...........	537,177	512,291	631,004	344,355	1,101,804	11,000	—	—	—	—
Hancock	540,575	484,906	562,636	203,037	150,000	—	—	—	—	—
Huron	364,579	720,213	1,927,660	2,271,163	1,992,695	1,881,760	2,370,857	2,215,000	1,758,748	1,215,734
Ridge...............	102,936	60,155	74,030	63,390	158,272	84,902	50,924	31,969	21,569	43,049
St. Clair	87,126	125 225	139,407	—	—	—	—	—	—	—
Cliff	66,053	10,374	28,225	—	22,342	—	—	—	—	363,009
Wolverine	25,623	699 622	751,763	328,610	3,125	2,330	—	—	—	—
Nonesuch.........	46,450	—	23,867	28,484	—	—	—	—	—	—
Isle Royal	35,447	—	16,074	—	—	—	—	—	—	—
Minong	21,380	3,582	—	—	—	—	—	—	—	—
National	17,060	26,006	87,368	162,252	184,706	25,187	—	495,000	123,879	109,[illegible]8
Minnesota	10,672	6,226	1,144	12,608	—	—	—	—	—	—
Belt	5,625	16.402	130,851	27,433	7,300	—	—	—	—	—
Sheldon and Columbia ...	3,299	—	9,828	—	—	—	—	—	—	—
Knowlton.........	—	—	—	—	—	—	3,300	2,000	20,000	7,120
Adventure	429	—	4,333	4,000	1,000	—	—	692	15,485	5,600
Peninsula.........	—	849,400	1,225,981	—	—	—	—	736,507	1,106,529	1,699,689
Tamarack	—	7,435	—	181,669	3,646,517	7,396,529	11,411,325	10,605,451	10,091,064	16,199,415
Ogima	4,207	3,000	1,106	12,000	—	—	—	—	—	—
Kearsage.........	—	—	—	—	—	21,237	829,185	1,918,849	1,616,556	1,731,075
Evergreen Bluff	—	—	954	1,500	1,000	—	41,000	28,773	25,000	—
Centennial	8 ,551	—	—	—	—	—	—	—	—	435,784
Other mines and tributers	75,765	—	23,213	34,000	50,000	50,000	50,000	25,000	36,494	50,177
Total	57,155,991	59,702,404	69,353,202	72,147,889	80,918,460	75,928,727	86,587,424	87,524,103	99,750,000	115,370,000

TABLE IV.—COPPER-PRODUCT OF ARIZONA.

[Compiled from *Engineering and Mining Journal.*]

Mine.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Copper Queen	7,700,000	6,721,535	3,800,000	5,945,550	9,379,949	9,408,000	9,408,000	10,034,608
Holbrook and Cave	——	——	——	——	3,042,468	2,561,144	3,047,310	2,730,257
Old Dominion.........	7,400,000	4,688,640	4,567,665	1,441,770	4,870,000	5,923,289	7,782,190	7,030,771
Arizona Copper.....	3,760,000	6,832,880	5,250,000	5,714,000	7,133,188	7,600,000	4,652,281	6,717,731
Detroit	2,940,000	3,456,000	2,135,000	4,404,321	5,420,224	5,076,890	4,976,890	4,193,568
United Verde........	3,680,000	——	——	272,124	3,200,000	1,923,738	5,675,602	6,591,182
Other mines............	1,254,345	1,007,301	247,335	12,235	154,171	440,000	167,727	2,401,883*
Total	26,734,345	22,706,356	16,000,000	17,790,000	33,200,000	32,933,061	35,720,000	39,700,000

* Of this 2,302,765 lbs. came from the Buffalo Mine, Globe not now producing.

TABLE V.—COPPER-PRODUCT OF MONTANA.

[Compiled from *Engineering and Mining Journal.*]

Mine.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Araconda	23,000,000	36,000,000	33,267,864	57,000,000	63,245,473	61,647,000	64,046,812	46,500,000*
Parrott	9,300,000	9,809,000	10,000,000	10,000,000	10,750,000	9,500,000	9,000,000	14,347,194†
Boston and Mont. .	6,600,000	7,500,000	2,000,000	1,500,000	18,278,667	26,425,228	26,822,804	26,786,330
Clark's Colusa.	600,000	10,000,000	7,000,000	7,100,000	700,000			
Butte Red. Works..	2,000,000	2,500,000	1,700,000	1,565,000	3,521,556	2,560,000	3,300,000	3,100,000
Col. S. & M.	——	1,200,000	2,000,000	1 500,000	1,488,000	2,951,000	2,320,000	3,975,400‡
Butte and Boston ...	——	——	——	——	——	1,103,125	5 357,723	18,134,343
All others................	4,593,054	789,864	1,643,621	34,677	521,295	400,000	162,661	356,730
Total	46,093,054	67,798,864	57,611,485	78,699,677	98,504,991	104,589,353	11·,010,000	113,200,000

* Product of five months' operations.

† Parrott copper is refined, and the silver separated by electrolysis at company's works at Bridgeport, Conn.

‡ The Colorado Smelting Mining Company's product, is shipped for treatment to Argo, Colorado. The company is affiliated with the Boston and Colorado Smelting Company.

DISCUSSION.

Mr. R. M. THOMPSON said he had come over from Paris to hear this paper, and had been much pleased and instructed by it. There was no one in the United States better qualified than Mr. Douglas to state the facts with regard to the production of copper. He could emphasize what had been said as to the improbability of any further surprises taking place in America on this subject. The carrying through of the great trans-continental lines had brought some of the mines in communication with the market, but there were no more similar regions to be opened out. Thousands of prospectors had been all over the country searching for copper mines, and, being a copper smelter in New York, he was called upon, on an average, six times a month by gentlemen who thought they had discovered a large mine. A small mine would be one with a pay streak of 100 feet wide; and hardly one was mentioned which did not promise to yield 30 per cent. of metal. But, as a matter of fact, the new mines which had actually come on the market in the last ten years could be numbered on the fingers of one hand; but those which had come—like the Anaconda and some of the older ones—had given a largely increased production. The owners, however, for some time, entered into a most suicidal war, and seemed to think only and how they could get the last pound of copper

out of the mine, instead of how they could work at a profit. The more favoured mines were able to get a new dollar for an old one, but many could only issue a favourable balance-sheet by means of most elaborate book-keeping; and, in some cases, the returns were produced more by selling bonds than by selling copper. They seemed now to have learned wisdom by experience, and their stockholders benefited accordingly. They were now so regulating production as not to entirely outrun the demand; but they were only brought to see the wisdom of this course by finding that they were working at a loss. He had been studying copper refining on this side of the water, and found he had a great deal to learn, which he hoped to take advantage of in future.

Mr. T. SANDERS said, as a merchant doing business with America, he knew something about the development of the American copper trade, but he had learned a good deal more from the paper. It was indisputable that America, at the present moment, held the primary position in the market, and practically had control of it. The supremacy which this country so long held as the great centre of copper smelting was seriously interfered with, and he feared it was prospectively doomed. At the same time, as they heard from Mr. Thompson that he still had something to learn, so no doubt had the English; and if they would learn what they could from America, and not stick entirely to the old lines, they might still manage to hold their own. He could not go in detail into the question of prices, but it must be recognised that the very low prices ruling some years ago had passed away, he would not say for ever, but certainly for the present generation, and the minimum price had certainly been raised some few pounds. Spain was a large producing country, and when it was found that America could turn out such vast quantities, working on ores with less than 1 per cent., he thought there need be no fear of the supply running short, although it might not be obtained at such very low prices.

Mr. J. H. COLLINS said he remembered making a journey of some 500 miles through Canada with Mr. Douglas in 1887; he had then been spending a short time at the Sudbury mines, which had just been creating quite a flutter in mining circles, and he well remembered his prophecy about those mines that they were not likely to be great producers of copper, or to be profitable for some time, but that they were likely to be large producers of nickel. Those prophecies had been strictly fulfilled, and he therefore felt some confidence in Mr. Douglas's forecast with regard to the future of copper. It was a good thing for consumers to get things cheap, but not for less than they cost, and for some time a great deal of copper used had been sold for less money than it cost to produce. He resided at Rio Tinto from 1881 to 1884, and knew something about it. The managers of that mine could perhaps produce copper cheaper than any of the large mines which had been mentioned, but even the Rio Tinto could not fairly continue to sell it at £40 a ton. He could speak from personal experience of the absolute accuracy of the description given of some of these mines, though not of all. Mr. Douglas had referred to three of the copper-producing districts, each having its own characteristics, and on the table he had placed samples of two of the products; if he could have added the third it would have been seen that the characteristics of the product were as distinct as the geological and physical characters of the places from which they came.

Mr. B. H. BROUGH said he visited some of the mines in Michigan now described in 1890, on the occasion of the visit of the Iron and Steel Institute to America, and what struck him more perhaps than the enormous output, was the high degree of perfection to which the management had been brought. Mr. Douglas had cited the remarkable case of the Tamarack mine, where a shaft had been sunk for some half a mile into the earth, without any absolute certainty of coming to any ore, the undertaking being simply based on a careful calculation of the dip, and the supposed regularity of the deposit. But a still more remarkable case was that of the Atlantic mine, which paid dividends on a mineral which contained only ·6 per cent. of copper; that was a feat without parallel in the history of mining, and could only have been accomplished by extreme excellence of management. They could only hope there would be the same good management in other parts of the world; for instance, in the case of the only other known example of a metal-bearing conglomerate—the gold mines of the Transvaal. It was gratifying to an Englishman on visiting the Lake mines to find that the majority of the miners were Cornishmen, and to see what might be accomplished where everything worked smoothly.

The CHAIRMAN then proposed a vote of thanks to Mr. Douglas. He was not disposed altogether to take a gloomy view of the future of the copper trade in this country, knowing that prophecies did not always turn out to be quite accurate. Many years ago, when the duty was taken off paper, paper makers were in a state of great dismay, especially as there was an export duty on rags from France and some other countries, but none in England. They accordingly waited on Mr. Gladstone and begged his attention to the matter. He, of course, expressed his sympathy with the sufferers, but said the country had committed itself to Free Trade, and advised them to try if they could not adapt their operations to the altered condition of things. It turned out that they were able to do so. A large bed of sulphur ore—as it was called—was found at Rio Tinto, and was sufficiently rich in sulphur to pay the expense of mining and carriage

for the use of the makers of soda and sulphuric acid, and it was brought here in large quantities for that purpose. Then it was discovered that it contained copper, on an average of two and a half per cent. It would hardly have paid, even at that time, to recover copper alone; but when there was 33 to 35 per cent. of sulphur also to be got out of it, the question was entirely altered. Then followed a wonderful series of changes. A very large demand sprang up for soda, in consequence of the cheapened production; and, at the same time, was discovered, in certain parts of Spain, a material known as Esparto grass, which was very useful for paper making. It was very light, and the great difficulty was to bring it as a cargo by itself, but, in conjunction with the copper and sulphur ores, it made a very good cargo. In the same way, he hoped that some good would turn up, in due time, which would save the copper trade from extinction, though at present they could not exactly see what it would be. In this country we had great facilities for exchanging commodities with other countries, but that was a state of things to which their friends on the other side of the Atlantic had not yet attained, and probably would not for some time, to its full extent, though their burden would perhaps be lightened. He had had the good fortune to visit one of the mines which Mr. Douglas had mentioned, the Calumet and Hecla, and he could testify to the accuracy with which he had described it.

The vote of thanks having been carried unanimously,

Mr. DOUGLAS, in reply, said he must disclaim the honour of being the second largest producer of copper in America, or even the third, though he produced a good deal. With regard to the price, he was not inclined to adopt the view of his friend, Mr. Thompson, that they had been making copper at a loss. They had made some little profit, notwithstanding the hard times; but no doubt some of the companies had been very greatly enlarging their plant, and it had not been always easy to keep the different accounts quite separate. What he meant to convey was, not that the copper industry of Swansea was at an end, but that the mines of America would cease sending matte; they would either finish their own product, or, at any rate, bring it up to such a stage in the manufacture, that it could be sold favourably in the English market. Perhaps the copper would not be all refined; most of the sulphur-bearing ores carrying silver would probably be made into electrolytic copper, which would probably come over here in that state to be refined and cut into whatever shape the manufacturer on this side might see fit to put it. America had not a monopoly of all the copper in the world; at the best it only produced from 48 per cent., and the remainder had to be accounted for. Then there were unexplored continents, which probably would have copper amongst their products, so that England, as the commercial centre of the world, would still receive large supplies of copper. He did not think, however, that after next year any large quantity of copper matte would reach the smelters of this country from America.

Miscellaneous.

GERMANY AND RUSSIA AT THE CHICAGO EXHIBITION.

The current number of the *North American Review* contains an article on "Europe at the World's Fair," which consists of reports by Consul-General Edwards on Germany, and by Consul-General Crawford on Russia. The following particulars are taken from it :—

GERMANY.

Mr. Edwards writes that the labours of the Imperial Commissioner, Herr Wermuth, are forming what will be "the grandest and most thorough display that German industries and arts ever made at any foreign exhibition." The German Government, in the first instance, granted a subsidy of 1,000,000 marks, and subsequently added a grant of 2,000,000 marks, thus making a total of 3,000,000 marks (£150,000) available.

"Some 250,000 square feet of floor space will, in all departments, be taken up by German exhibits. The Industrial Building will be occupied to the extent of 100,000 square feet, and in the Machinery Hall, 30,000 or 40,000; in the Art Building, 20,000; and in the Electric Building, 20,000 square feet will be needed. Similar spaces are required in the Agricultural and Horticultural Halls and the Department of Mining.

"The Railway and Transportation Department will also be thoroughly represented. One of the chief, if not the main, exhibitions of German skill and industry will be made in the textile branch.

"Musical instruments will come from all over Germany—Plauen, Berlin, Leipzig, and Dresden; in fact, all the centres of the musical trade will send their products. The exhibition of chemicals and dyes will be very profuse.

"The iron and steel industry of the great Westphalia and Rhenish manufacturing centres are making efforts for proper representation. Machines of every sort, those adapted to the peaceful pursuits of mankind, as well as the monster engines of war, will be exhibited. Another great display will be that of industrial art, which has obtained great proportions in Germany. The famous porcelain of Berlin and Dresden, the industrial art products of Munich, Carlsruhe, and Hanover will be sent to Chicago in large quantities and wonderful variety.

"Art itself, painting and sculpture, will be worthily represented. The art academies and artists' societies of Berlin, Munich, Dusseldorf, Weimar, and Dresden are preparing exhibits.

"The purposes of science will be served by a large display of optical and scientific instruments and wares."

There will be a display of toys from the Erzgebirge, Sonneberg, and historical Nuremberg. The cheapest, as well as the most costly and intricate, toys which Germany produces, will be found in this department.

The German Government expects to have a great mineralogical collection on view.

Agriculture will be represented by agricultural machinery, specimens of grains, grasses, seeds, fruits, and wines. The preserved fruits of Germany, the beet-sugar of Magdeburg, and other agricultural products of Germany, will be exhibited. It is also proposed to send over specimens of the fine horses and cattle of the German marshes and of Holstein. There will be a department for the wines of the Rhine and Main, and the Moselle, as well as beers of Munich and Berlin.

Germany will be fully represented in the Department of Women's Work, which will be divided into four sub-divisions.

One of the features of the German exhibition will be the "German Village of the Middle Ages" in the Midway Plaisance. This will show the architecture and home life of the German peasants of the Middle Ages, and also the household industries and German village life of the present day.

Russia.

The Emperor has ordered that all expenses whatsoever necessary to make a full and favourable exhibit of Russian goods at Chicago shall be paid out of the Imperial Treasury. These expenses may be summarised as follows:—

1. Transportation from St. Petersburg to Chicago, and return of all goods regarded worthy of exhibition.

2. Insurance of all such wares against loss or damage on sea or on land.

3. Expenses of installation and decoration of the goods of the Russian Section, including suitable show-cases and furniture.

4. As all goods designed for the Exposition must be collected at St. Petersburg, it has been ordered that all steamboat and railway companies in the empire shall reduce their tariff 50 per cent. on all such exhibits from all inland points of European or Asiatic Russia to St. Petersburg.

It will thus be seen that Russian exhibitors will have practically no expense in order to expose their products at Chicago.

The Governors-General of distant districts, such as the Caucasus, Siberia, Turkestan, Finland, &c., have received orders from the Government to use every effort to aid the Imperial Commission at St. Petersburg. The different branches of the Imperial Government will be specially represented.

The model of the first ship of the Russian fleet, built by Peter the Great, will be an attractive feature of the Russian Section. The Ministry of Navy has decided, under special application, to send a large number of the models of the Russian fleet. Sketches and models of ships specially constructed for the transport of petroleum will also be on exhibition.

The Ministry of War is preparing a fine collection of various military objects, made in the factories and workshops of Russia, and a complete set of the military works, edited by the War Scientific Department, will be sent to Chicago.

The Ministry of Public Domains will exhibit a complete collection of the agricultural products of Russia, including all sorts of fruit, vegetables, cereals, wood, and the products of the stone and metal mills, as well as the fisheries belonging to the Government.

The Ministry of Public Instruction is taking great pains to furnish to the visitors of the World's Fair a correct idea of the present state of public schools in Russia, covering elementary school work, as well as that of the academies, colleges, technical and professional schools, gymnasiums, and universities.

The Department of Appanage will exhibit wines in great variety, in bottles and in casks, from the immense vineyards of the Emperor, and situated in the Caucasus, Crimea, and Bessarabia.

Consul-General Crawford adds, from his own personal observation, that the exhibits of private merchants and manufacturers may be confidently expected to cover almost every form of Russian wares, such as enamelled silver, Russian bronzes, papier maché, vases of Siberian stones in every variety, hand-wrought rugs and carpets, portieres and hangings, silken linen, cotton, woollen, and silver fabrics, embroideries, furs, glass and porcelain, terra cotta, metal goods, &c.

A Board of Lady Commissioners has been appointed to form a complete exhibit of women's work.

The exhibition of art in all its branches will be under the supervision of Count Jean Tolstoi. The great marine artist, Aivazoffsky, will exhibit several paintings relative to the discovery of America by Columbus.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock:—

December 7.—"The Chicago Exhibition, 1893." By James Dredge. Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., will preside.

December 14.—"The Utilisation of Niagara." By Prof. George Forbes, F.R.S. Sir Richard Webster, Q.C., M.P., will preside.

Papers for meetings after Christmas:—

"Transatlantic Steamships." By Prof. Francis Elgar, LL.D.

"The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air." By Prof. Frank Clowes, D.Sc.

"The Purification of the Air Supply to Public Buildings and Dwellings." By William Key.

"Pottery Glazes: their Classification and Decorative Value in Ceramic Design." By WILTON P. RIX.

"On some Points in the Chemical Technology of Oil Boiling, with an account of a New Process for Preparing Drying Oils, for Decorators' and Artists' use." By PROF. W. NOEL HARTLEY, F.R.S.

"The Mining Industries of South Africa." By BENNETT H. BROUGH.

"Ten Years of Progress in India." By SIR WILLIAM WILSON HUNTER, K.C.S.I., C.I.E., LL.D.

"Australasia as a Field for Anglo-Indian Colonisation." By SIR EDWARD N. C. BRADDON, K.C.M.G., Agent-General for Tasmania.

"Indian Manufactures." By SIR JULAND DANVERS, K.C.S.I., late Public Works Secretary, India-office.

"Caste and Occupation at the last Census of India." By JERVOISE ATHELSTANE BAINES, I.C.S., Imperial Census Commissioner for India.

"Mexico, Past and Present." By EDWARD J. HOWELL.

"Newfoundland." By CECIL FANE.

"New Zealand." By W. B. PERCIVAL, Agent-General for New Zealand.

"British Rule in Burma." By H. THIRKELL WHITE, C.I.E.

"The Currency Problem." By J. BARR ROBERTSON.

"Agrarian Legislation for the Deccan, and its Results." By SIR RAYMOND WEST, C.I.E.

CANTOR LECTURES.

PROF. VIVIAN LEWES, "The Generation of Light from Coal Gas." Four Lectures.

LECTURE III. — DECEMBER 5. — Theories of luminosity as they at present exist—The genesis of the gas burner—Flat flames, argands, regenerative and incandescent burners—The gas burner in relation to the gas to be burned.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 5 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "The Generation of Light from Coal Gas." (Lecture III.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 6 p.m. Mr. S. B. L. Druce, "The Jubilee of the Farmers' Club."

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. A. G. Drury, "The Shortland and Nunhead Railway."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. C. C. Hutchinson, "A New Form of Filter Press for Laboratory Use." 2. Messrs. Cross and Bevan, "The Production of Acetic Acid from Carbohydrates." 3. Messrs. Cross and Bevan, "Electrolytic Soda and Chlorine: The Present Aspects of the Question."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. J. Douglas Walker, "Rights of Way."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Captain Gallwey, "Journeys in Benin."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. C. Street, "Some Problems of Town and City Developments."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Prof. Parker, "Principles of Rank among Animals."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Edmund Gosee, "Reading as a Recreation."

TUESDAY, DEC. 6 ... Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. John Rigby's paper, "The Manufacture of Small Arms."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. Sydney J. Hickson, "A Revision of the Genera of the Alcyonaria Stolonifera, with Descriptions of one new Genus and several new Species." 2. Mr. F. E. Beddard, "Upon the Convolutions of the Cerebral Hemispheres in certain Rodents." 3. Professor Collett, "On a new Monkey from S.E. Sumatra."

WEDNESDAY, DEC. 7 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. James Dredge, "The Chicago Exhibition, 1893."

Geological, Burlington-house, W., 8 p.m.

Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. Edward B. Poulton, "Further Observations upon Lepidoptera." 2. Mr. Frederic Merrifield, "The Effects of Temperature on the Colouring of *Pieris napi*, *Vanessa atalanta*, *Chrysophanus phlæas*, and *Tephrosia punctulata*. 3. Mr. Kenneth J. Morton, "Notes on *Hydroptilidæ* belonging to the European Fauna, with Descriptions of New Species." 4. Dr. Thomas Algernon Chapman, "Some Neglected Points in the Structure of the Pupa of Heterocerous Lepidoptera, and their Probable Value in Classification; with some Associated Observations on Larval Prolegs." 5. Mr. James Cosmo Melvill, "Description of a New Species of Butterfly, of the Genus *Calinaga*, from Siam."

Archæological Association, 32, Sackville-street, W. 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

THURSDAY, DEC. 8...Japan Society (at the HOUSE of the SOCIETY OF ARTS), 8½ p.m. Mrs. Galwey, "Japanese Fans."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Sir Joseph Barnby, "A Plea for the Catholicity of Taste in Music."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Annual Meeting.

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, DEC. 9...Astronomical, Burlington-house, W. 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Mr. W. B. Croft, "On Colour Vision." 2. Prof. S. P. Thompson, "On Magic Mirrors." 3. Dr. Sumpner, "On the Diffusion of Light."

SATURDAY, DEC. 10...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

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FRIDAY, DECEMBER 9, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 4 and 11, by R. Bowdler Sharpe, LL.D., on "The Curiosities of Bird Life."

The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult.

CANTOR LECTURES.

On Monday evening, 5th inst., Prof. Vivian Lewes delivered the third lecture of his course on the "Generation of Light from Coal Gas."

The lectures will be printed in the *Journal* during the Christmas recess.

APPLIED ART SECTION.

A meeting of the Committee of the Section was held on Friday, 2nd inst., at 4 p.m. Present: Sir George Birdwood, K.C.I.E., C.S.I., M.D., in the chair; J. Hunter Donaldson, Major-General J. F. D. Donnelly, R.E., C.B., C. M. Kennedy, C.B., A. Lazenby Liberty, J. H. Pollen, Vincent J. Robinson, R. Phené Spiers, Hugh Stannus, Thomas Wardle, W. H. J. Weale, with Sir Henry Trueman Wood, Secretary of the Society, and H. B. Wheatley, Secretary of the Section. The programme of papers to be read during the present Session was discussed.

MULREADY PRIZE.

The Council of the Society of Arts have awarded the Mulready Prize of £20 (on the adjudication of the examiners of the Science and Art Department) to Laura Margaret Fisher, of the Clapham School of Art, Vernon-road, Clapham, S.W., who obtained a Gold Medal for a finished drawing, of imperial size, from the nude living model, and a book prize for studies of hands and feet in the National Competition, and a 2nd Class for her Third Grade Examination in drawing from the living model.

Chicago Exhibition, 1893.

ELECTRICITY COMMITTEE.

A meeting of the Committee on Electricity was held on Thursday, 1st inst. Present: William H. Preece, F.R.S., in the chair; Prof. George Forbes, F.R.S., H. Graham Harris, Prof. D. E. Hughes, F.R.S., W. M. Mordey, James Paxman, Mark Robinson, Alexander Siemens, James Swinburne, Prof. Silvanus Thompson, F.R.S., Major-General C. E. Webber, C.B., with Sir Henry Trueman Wood, Secretary to the Royal Commission.

Proceedings of the Society.

FOURTH ORDINARY MEETING.

Wednesday, Dec. 9th, 1892; Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Harwood, Arthur, Brighton-house, Heckmondwike, Yorkshire.

Knowles, C. J., Shaftesbury-house, Kensington, W.
Murch, Philip, The Town-hall, Portsmouth.

The following candidates were balloted for and duly elected members of the Society :—

Barlow, H. Dudley, care of Messrs. J. and P. Coats and Co., Paisley, N.B.
Benson, Walter, Stoneleigh, St. George's-avenue, Weybridge, Surrey.
Edwards, Stanley, 24, Fenchurch-street, E.C., and Kidbrooke-lodge, Blackheath, S.E.
Parker, Hon. Cecil Thomas, The Paddocks, Eccleston, Chester.
Thompson, Bernard H., Royal Engineers'-office, Windsor.
White, William, 58, Bread-street, E.C.
Young, Robert G., The County Asylum, Colney-hatch, N.

The paper read was—

THE WORLD'S COLUMBIAN EXPOSITION OF 1893.*

By JAMES DREDGE,

Member of the Royal British Commission.

1. *Introductory.*—On two previous occasions I have had the privilege of addressing an audience in this room on the subject of the World's Fair which is to be held in the City of Chicago next year. In December, 1890, the date of my first paper, but little was known of the project in this country, and it then was, in fact, full of uncertainty and of somewhat doubtful issue. The City of Chicago had, indeed, received from the United States Government the privilege of holding the Exhibition, and felt no hesitation in facing the material and financial difficulties connected with the undertaking, the extent of which was quite unknown. The site had not been definitely decided, and nearly the whole area finally allotted to the purpose was little better than wilderness. The general plan of the Exhibition was unsettled, and no detailed designs had been commenced. The administrative organisation had to be formed, and there was as yet no work for an executive staff. In short, all was uncertain except the determination of the people of Chicago that the World's Fair of 1893 should be the greatest, the most magnificent, and the completest exhibition that had ever astonished the world. And not for a single moment, since it was first formed, has this determination faltered. How far it has been materialised can only be fully judged next year, but I hope this evening to enable you to arrive at some conclusion on the subject.

2. At the date of my second paper, read before you last December, a marvellous progress had been effected. Organisation was complete; the general plan of the Exhibition had been settled, and, with a few changes, has been strictly adhered to. The designs for the various great buildings had been prepared by the architects of many States; these designs had been approved; important contracts had been let, and much work had been done, although, with the exception of one building, but little was visible above the surface of the ground. Although the site of the Exhibition had been contracted within the limits of Jackson-park, the extent and designs of the buildings had so far exceeded the original intention as already to give anxiety to those responsible for the finance of the undertaking. Foreign nations had, through their respective Governments, signified their intention to participate, and had thus raised the Exhibition to full International dignity; opposition and prejudice were rapidly dying out of America, and interest was beginning to be aroused in Europe. Almost all the States of the Union had voted large sums for collective exhibits, and the system of classifying the contents of the Exhibition had been settled in detail. Besides all this, much work peculiar to the Columbian Exposition was in full and active progress. The nominal reason for holding it was the celebration of the four hundredth anniversary of the discovery of America by Christopher Columbus. No temple raised in honour of the tutelary saint of the New World could be complete unless every available relic were collected there within a suitable shrine. Therefore to Central America, to the West India Islands, and to South America, messengers were despatched by the United States Government, with instructions to secure as loans, and in many cases as purchases, objects directly associated with the memory of the great discoverer, and not only of Columbus, but also of the chief of those adventurers who succeeded him, seeking conquests in the New World. The shrine in and around which these relics are to be displayed will also have a direct association with Columbus. It will be the reproduction of the Convent of Da Rabida, near Palos, where the Spanish celebrations took

* This paper (read in abstract) was illustrated by a large number of lantern slides, most of which were prepared from photographs kindly supplied by Mr. C. D. Arnold, Official Photographer of the Exhibition.

place in October last; it will stand upon a height overlooking Lake Michigan, and below it will be moored the reproductions of the three vessels that formed Columbus's fleet, and which took so conspicuous a part at the celebrations at Palos above referred to. This may be regarded as the sentimental portion of the Exposition, although its effect will be more important than that of simply arousing enthusiasm in the American people. Those countries which have contributed these relics, are purchasing, but not manufacturing, countries; to a very large extent they are our customers, but the American manufacturer and merchant see no reason why they should continue to be so, and it is not an unreasonable ambition on their part that, after the sentimental effect has evaporated, a good residue of profitable commerce taken from ourselves should remain. It is for our manufacturers and merchants to realise this danger that awaits them—a danger which can be averted if proper care be taken, but which will certainly fall upon us if we do not modify our present system of foreign trade, and continue to persist in the belief that England by divine right must always control the commerce of the world.

3. *Progress of Works.*—It is very difficult to convey an idea of the work that has been done in Jackson-park in the short space of twelve months, during which time many precious days were lost by stress of weather. Even the directors and the engineers of the Exposition must be lost in astonishment at what they have accomplished, and it is well to emphasize this, because results, however great, are so easily forgotten in the rapid age in which we live. A few facts and figures may help to do justice to the work achieved, and to those who have accomplished it. It was in April, 1890, that Chicago was selected as the city of the Exhibition by Congress; three months were occupied in preliminary financial arrangements, and the first practical step taken was the appointment of Messrs. F. L. Olmsted and Co. as consulting landscape architects; this was in the August following. In September Messrs. Burnham and Root were appointed consulting architects, and Mr. A. Gottlieb as consulting engineer. The general plan of the Exhibition was decided upon in November, and the designs of the chief buildings were entrusted to architects of prominence in various cities. These designs were not accepted before the close of the winter of 1891, and in March the necessary staff was organised for the preparation of the work. The duties of the architects who prepared the designs did not extend to details of construction other than those connected with the façades; all internal design and engineering had to be worked out by Mr. Burnham in consultation with Mr. Gottlieb, who, however, resigned in August, 1891. In the spring of that year the work of preparation in Jackson-park commenced; this in itself was a gigantic labour. At the time when it was handed over to the Exhibition executive, excepting for a small reclaimed portion, it was a wholly unreclaimed marshy tract, with a scanty vegetation of scrub oak. To obtain the necessary levels, 1,500,000 cubic yards of earth had to be obtained from some source and distributed over different parts of the park. This necessity rendered the introduction of extensive waterways and lakes inevitable, because the only means of obtaining the material required in some places, was to excavate it from others. Messrs. Olmsted and Co. quickly learned how to turn this necessity to useful account, and the waterways of the Exposition grounds will be one of their chief attractions. The problem that was presented for solution to the executive in the spring of 1891 can perhaps be best described in Mr. Burnham's own words: — "It was necssary that the vast area of Jackson-park should be reclaimed, and in twenty months transformed from a desolate waste into a park highly improved and embellished with all that skilled designers could suggest; that upon the stately terraces a dozen or more palaces of great extent be constructed, and that they be supplemented by over 200 other buildings, some of which are almost of the importance and size of the main structures; that great canals, basins, lagoons, and islands be formed; that extensive docks, bridges, and towers be constructed. It was necessary that a standard of excellence be obtained which would place the work upon an equality with the monuments of other ages—it meant, in short, that an organisation be quickly formed which would associate together the ablest architects, painters, and sculptors of the world. Many of the great problems to be solved were new, no precedent having been established for the guidance of those assuming this great responsibility."

4. *Available Space.*—It is not too much to say that all this has been done, and, indeed, the promises of the engineers and architects have been more than fulfilled, for at the date of the dedication ceremonies in October last, nearly

all the buildings were practically completed as regards constructive detail, leaving little but surface decoration to be done, and, for the first time in the history of exhibitions, the buildings were open to exhibitors to instal their exhibits six months before the date of the opening, the work of installation having commenced on the 1st of November last. The main buildings cover an area of more than 5,500,000 square feet, or over 123 acres; smaller and less important buildings still under construction occupy 1,155,000 square feet, or about 26 acres; State buildings occupy about 420,000 square feet; foreign buildings about 300,000 square feet, concession buildings 1,000,000 square feet. So that the total area of all the buildings in the Exhibition grounds is no less than 190 acres. As regards the actual available space for exhibits, Director-General Davis places it at about 3,000,000 square feet, and it will be interesting to examine for the moment into the claims made by foreign countries for this space, because that will afford some indication of the interest shown by the world in the Columbian Exposition. Foreign countries have, we find, applied for 2,500,000 square feet of space out of the 3,000,000 square feet available, or 85 per cent of the total. American exhibitors on their part have asked for 5,000,000 square feet, so that the total amount of space demanded has been no less than 7,500,000 square feet—that is to say, that the largest exhibition which has yet been attempted must have been nearly twice its present size to have satisfied the claims of exhibitors. Surely nothing more convincing can be furnished than these figures, to prove the popularity and future importance of the World's Columbian Exposition. It being impossible to satisfy these demands, the work of restriction had to be severely carried out both for home and foreign exhibitors, and this in every department. The Director-General has followed the rule common on these occasions of dividing available space almost equally between home and foreign exhibitors; to the former 1,300,000 square feet have been allotted, which is little less than half the total space available, and only a little more than half that asked for. The remaining 1,700,000 square feet is divided among the exhibitors of the United States, and as since the expiry of the date for receiving applications, further demands are being constantly made, the space available is sufficient to satisfy only one-fourth of the demands, and this proportion appears to hold good in most departments.

5. *Executive Staff.* — A few important changes have taken place since last year in the *personnel* and executive of the Exhibition Administration. The chief of these changes are as follows:—The President of the Exhibition, the Hon. T. W. Baker, resigned the arduous and responsible position last summer, and has been succeeded by Mr. Higginbotham, one of the partners in the famous firm of Marshall, Field, and Co., of Chicago. Mr. William Prettyman, a well-known English artist, and chief of the department of colour, also resigned early in the summer. He was succeeded by Mr. Francis D. Millett. Much more recently Mr. Robert S. McCormick, who had long and ably filled the position of American representative of the Exhibition in England, was compelled to resign on account of urgent private affairs; Mr. McCormick was assisted by Commander W. Bainbridge Hoff, of the United States Navy, a gentleman detailed to England last spring by the American Government for that purpose. The following is a list of the principal engineers and architects employed in the design of the buildings and grounds:—

Mr. D. H. Burnham; chief engineer and chief of construction.

Messrs. F. L. Olmsted and Co.; landscape architects.

Mr. Richard M. Hunt, New York; architect of Administration Building.

Messrs. Adler and Co., Chicago; Transportation Building.

Messrs. McKim, Mead, and White, New York; Agricultural Building.

Mr. W. L. B. Jenny; Horticultural Building.

Mr. George B. Post, New York; Manufactures and Liberal Arts Building.

Mr. Henry Ives Cobb, Chicago; Fisheries Building.

Messrs. Peabody and Sterns, Boston; Machinery Hall.

Messrs. Burling and Whitehouse; Choral Building.

Messrs. Van Brunt and Howe, Kansas City; Electrical Building.

Messrs. Holabird and Roche, Chicago; Stock Ring and Pavilion.

Mr. S. S. Beman, Chicago; Mines and Mining Building.

Mr. Charles B. Attwood, Chicago; Fine Arts Building, Music Hall, and Casino, railway terminal station, guards' stations, fire stations, balustrades, bridges, &c.

The chief engineers of departments under Mr. Burnham are:—Mr. R. Graham, assistant chief of instruction; Mr. Frederick Sargeant,

mechanical and electrical engineer; Mr. E. G. Nourse, engineer of railroads; Mr. William S. MacHarg, engineer of water supply, sanitation, and fire protection; Mr. J. W. Alvord, engineer of grades and surveys; Miss Sophia G. Haydon, architect of the Women's Building. As already stated, all construction works have been carried out in the office of Mr. Burnham.

6. *Alterations in Plan of Exhibition.*—The alterations in the general plan of the Exhibition are insignificant since I explained their arrangement to this meeting a year ago, and consist chiefly in the filling in of details. The plan of the terminal station, to which visitors will be conveyed from the city, is definitely settled, and is practically complete; its location is that originally decided upon, at the back of the Administration Building. The space for warehouses, in which the empty packing-cases of exhibits will be stored, is also decided upon. It is situated outside the Exhibition grounds, adjoining the agricultural space, and alongside the railway station yard, where very extensive sidings are provided. The open space at the back of the Agricultural Building, reserved for stock and similar exhibits, has been considerably encroached upon by additional small buildings; the sheds are now larger and more numerous; the Stock Pavilion at the back of the covered gallery connecting the Agricultural and Machinery Buildings also occupies a good deal of ground. The Concert-halls at the eastern end of the great basin and adjoining the lake have now taken the definite form shown in the plan published in a recent issue of the Society of Arts' *Journal;* they are connected by a long covered gallery of considerable architectural pretensions. The north side of the ground at the back of the Fine Arts Gallery is crowded with the buildings of the different States, and the space between the front of that gallery and the Fisheries Building is also being rapidly covered with the pavilions and offices of foreign nations. On a spare piece of ground between the Transportation and Horticultural Buildings, a Choral Hall has been erected, and numerous stations are being constructed along the line of the electric railway. These constitute the only important changes that have been made in the plan during the past year. The whole extent of the Midway Plaisance, a mile in length, is entirely taken up with allotments. Most of this space will be occupied by attractions — largely Oriental — from foreign countries; but there will also be a number of specially American exhibits and entertainments.

7. *Communication within the Exhibition.*—As already said, there will be in all 190 acres of buildings filled with exhibits. The fatigue that must necessarily be incurred by the visitor by merely walking through these buildings may be easily imagined. And it is not only the extent of such a promenade that causes fatigue, but the fact that the attention is attracted at every step by some object of interest, and in order to gain even a superficial idea of the contents of the buildings, considerable feats of pedestrianism must be accomplished. Assuming that one-half of the total area is occupied by passage ways, and that these on an average are 20 ft. in width, the total length of such promenades would be about 50 miles; add to this that in the best ventilated buildings the presence of vast crowds, especially during the summer months, produces very unfavourable atmospheric conditions—it will be remembered that on many occasions the Machinery Hall in Paris was almost unbearable—and it will be conceded that the visitor who proposes to make himself thoroughly acquainted with the Columbian Exposition will have before him a task of no small magnitude. Although the buildings are placed so close together that at the present time there appears room for the erection of no more on Jackson-park, still the distances to be traversed in going from one to another are very considerable. The frontage on the lake from north to south is nearly two miles. The greatest depth is not far short of a mile; the Midway Plaisance, which forms an extension from Jackson-park, is a mile in length. Two causes will probably contribute largely to an unusual amount of activity on the part of visitors. The cost of living in Chicago during the period of the Exhibition will undoubtedly be great, and will therefore check the tendency of visitors to prolong their stay. The price of admission having been fixed at 2s., will not unlikely have the effect of reducing the number of visits paid by each person, and the labour of seeing the Exhibition will consequently be harder, because more concentrated. In Paris, when the Exhibition was, so to speak, at the doors of the people; when the ordinary price of admission was never more than 10d., and frequently fell as low as 3d., the Champs de Mars formed a delightful pleasure ground for millions who could repeat their visits day by day.

8. Under the very different conditions that will exist at Chicago, means of communication between the different buildings and with all parts of the grounds will become an absolute necessity. This has been thoroughly understood, and is being provided for as far as possible by the authorities. Canals having a length of 2½ miles have been laid out within the grounds, and a very large fleet of small boats will be at the disposal of passengers. These boats will in all cases be driven by storage batteries, which will be charged at different electric stations provided for that purpose. They will be of three classes: express boats making the round trip without any stops; local boats stopping at stations connected with every building; and private boats, which can be hired by the hour, like gondolas, but certainly not at the same rate. In addition to this means of transport, an electric elevated railway will run around the grounds. It will commence at the back of the Agricultural Hall, and running outside the Machinery Hall and its annex, will pass behind the Transportation, Horticultural, and Women's Buildings, where there will be a station for the Midway Plaisance; then up to the extreme northern boundary of the grounds, to accommodate the group of States buildings, and southward to the group of Art Galleries, the district of foreign pavilions, the Fisheries and Government Buildings, and the Naval Exhibit. Here, making a loop, it returns by the same course, until it joins, in another loop, the line at its commencement at the back of the Agricultural Hall. The total circuit made by this railway is over five miles, and as throughout its whole course it lies within the Exhibition grounds, its value to visitors will be at once appreciated. The third means of transport is so novel and ingenious that it deserves some detailed description. Although the pier, that forms an extension of the great central court into the lake, where it serves as one arm of the harbour constructed for the smaller class of naval exhibits, appears insignificant upon the plan, it is none the less of considerable length, especially after a hard day's work and under a burning sun, and doubtless many thousands of visitors returning homeward by the steamers which will ply between this pier and the city, will gladly avail themselves of the means of transportation which is to be laid down upon the pier. This is the "movable" side-walk, and the pedestrian can step upon it at any time, and then be carried forward without further exertion. When he arrives at the end of his journey he can step off with equal facility. The principle upon which this means of locomotion is based is as follows:—An endless platform of convenient width, and placed either level with the road or a few inches above it (or on an elevated staging as the case might be), is constantly driven at a very low rate of speed—say at two miles an hour; upon this platform anyone can step without inconvenience and be carried forward upon it. Beside the travelling platform is another of convenient width also travelling constantly, but at a higher speed of perhaps four miles an hour. This increased speed, it will at once be seen, is, relatively to that of the first platform, only two miles an hour, so that the passenger can step upon the faster platform from the slower, and double his speed without any inconvenience. A third and similar platform alongside the second would increase his speed to six miles, and so on. The inventor of this ingenious system claims that by the arrangement speeds of ten or twelve miles an hour can be arrived at, and that more passengers can be accommodated by it than on any other method that can be devised. Seats are provided on the various platforms for the accommodation of travellers, who will have to pay a uniform fare for any distance, on quitting the railway. There appear to be at first sight certain difficulties in the way of collecting the fares upon this line, but no doubt these will be got over with the same ingenuity that has devised the movable sidewalk.

9. The Midway Plaisance will, undoubtedly, be one of the most crowded portions of the Exhibition, and, as it is a mile in length, some means of conveying passengers on an extensive scale are necessary. The system proposed for this purpose is one which attracted considerable attention in Paris during the year 1889. It is known as the Gifford Water Railway, and consists of an elevated track, on which are laid very heavy, broad, flat rails. Below the track, and along its centre, is laid a water main, with hydrants, terminating in nozzles, rising from it at intervals. The carriages have no wheels, but rest on shoes which bear upon the rails. When it is desired to set these carriages in motion, water is introduced between each shoe and the rail, and, at such a pressure, that the train is entirely waterborne. Propulsion is effected by a series of water jets issuing from the nozzles before spoken of, and which are opened and closed automatically, as the train passes over them.

It is needless to point out that considerable volumes of water and high pressures are necessary to drive such a train at moderate speeds. Great things are claimed for this system by the inventors; the merit of novelty may be fully conceded to it; and its practical value will, doubtless, be well tested at the Exhibition.

10. *Transport of Visitors.*—The considerable distance between Jackson-park and the city involved the necessity of solving a problem of vital importance, and of a very great magnitude. The vast crowds who are expected to visit the Exhibition daily will have to be conveyed to and from it with the least inconvenience to themselves, and with the greatest possible despatch. Bringing visitors to Chicago from all parts of the country, and taking them away again, is another problem of no small magnitude, but this is one with which the Exhibition authorities have nothing to do, and which may be safely left in the hands of the railroad companies that possess terminal facilities in, or in connection with, Chicago. Relating to this subject it may be mentioned that all excursion trains bringing passengers to the Exhibition will discharge and receive them at the terminal station within the grounds, and will not enter the city at all. One means of communication that will exist between Chicago and Jackson-park will be the street railways, chiefly cable lines; the capacity of these lines is now being very largely increased, and will be still further extended by the 1st of May. There will also be a steamboat service running between a pier on the city water front and the Exhibition pier in Jackson-park. It is intended that these vessels shall be large and numerous enough to deal with 15,000 passengers an hour. This means of communication will be very pleasant in fine weather, and sufficiently expeditious. Hired vehicles, especially Hansom cabs, will supply a limited means of communication; but, although the tariff in Chicago is comparatively moderate, this method of reaching the Exhibition will hardly be a popular one. One of the chief means of communication will be the new elevated railroad, built by the Illinois Central Railroad Company. This line, which will be of very considerable capacity, will doubtless form one of the most efficient means of dealing with the traffic. Finally, there is the existing line of the Illinois Central Railroad Company, that starts from its terminal station on the city front, and runs almost close to the grounds. In ordinary times it consists of six tracks, two of which are reserved for suburban traffic. These are now supplemented by four other lines exclusively for the Exhibition: two of these will be used for express service, and the other two for stopping trains. The disadvantages inseparable from the working of service lines in crowded cities will be avoided as far as possible, and the traffic will be worked entirely on the block system; by this means the safety of the public in the streets and of those using the trains will be provided for. The great crowd which flocked to and from Jackson-park on the occasion of the recent dedication ceremonies was a severe test to the scarcely-completed lines of communication. The local accounts differed widely as to the way in which the work was done, some of the newspapers claiming a complete success, while others reported something little short of failure. Probably the truth lay between the extremes, and there appears little danger of the extensive preparations being made, breaking down after the Exposition opens, although they will certainly be exposed to constant and excessive strain, especially during the hours of concentrated traffic.

11. *Fire Protection.*—Naturally every possible arrangement has been made to prevent the outbreak of fire in any part of the Exhibition, and to subdue it in case a conflagration should take place. The Exhibition authorities have been in close communication with a group of fire insurance companies, and a total insurance of 4,500,000 dols. has been effected on the buildings. It was under the supervision of the insurance companies' officers that the fire system has been laid out. This system comprises appliances for ready means of access to every part of each building. Mains are laid all over the grounds, with hydrants at frequent intervals, and the water pressure will be sufficiently great to throw an ample stream over the highest structures. The installation in the grounds consists of three steam fire-engines, and connections with four of the city fire stations; of 20,000 feet of hose; 960 fire extinguishers, and 2,750 fire pails. It is probable that this service will be nearly doubled before the opening of the Exposition. In addition to the foregoing, a floating fire-engine, the Fire Queen, has been recently launched. The boat is 65 ft. long, 16 ft. beam, and 6 ft. deep; her pumps will throw 1,500 gallons of water per minute to a

height of 300 ft. The fact that the grounds are intersected with canals will enable this floating fire-engine to be brought to any part with little delay. There will be 350 hydrants distributed over the 27 miles of water mains in the grounds. These mains are connected with one of the present city pumping stations, which can concentrate a supply of 24,000,000 gallons daily into the Exhibition, and they will be supplemented by the pumping station within the grounds, which will have a daily capacity of 12,000,000 gallons. A large and efficient fire brigade is kept constantly on service, so that every possible precaution has been taken to avert any danger from this source.

12. *Department of Publicity.*— Amongst the several novel and ingenious features connected with the organisation and arrangement of the World's Fair, a few words should be said about the Department of Promotion and Publicity. The special object of this department, which was established quite early in the history of the Exhibition, has been to disseminate information, and to attract attention to the Fair in all parts of the world. Major Moses P. Handy, the chief of this department, has recently supplied some very interesting statistics about the work done under his supervision. The department was organised in December, 1890; its first object was to overcome indifference and prejudice that existed abroad, and to make known the aim and scope of the great undertaking. Organised communication was first of all established between the department and the press of the United States, and in fact of all newspapers throughout the world. Articles, written in more or less glowing terms, explaining the purpose and importance of the Exhibition, the remarkable suitability of Chicago and its site, and the advantages to be derived by exhibitors and visitors, were scattered broadcast throughout the world; of course the largest editions of these articles were published in English, but translations in French, German, Spanish, Portuguese, Swedish, Danish, and Italian were also sent out wholesale. In answer to these preliminary appeals, some 2,000 newspapers and other publications placed themselves in communication with the department, to which a flood of periodical literature steadily set in. For a considerable period the department was the only source in America whence information could be obtained, and whilst, as may be expected, those newspapers that limited themselves to reprint the items furnished them, spoke uniformly in glowing terms of praise about the Exposition, it is also worthy of note that but very little hostile criticism was offered. It should also be placed on record, in justice to Major Handy, that, with the unlimited opportunity and temptation which he had to circulate highly-coloured and exaggerated statements about the future importance and magnitude of the Exhibition, everything which has been issued from his department has been fully justified by results. In the course of a few months the work of publicity grew to very large dimensions, until at the beginning of the present year some columns of printed information were sent each week to no less than 23,509 addresses in the United States; in addition to this, 13,846 similar communications were forwarded every week to foreign addresses, distributed amongst 75 different nations and colonies. On the other hand, the list of newspapers, daily and weekly, copies of which poured into the department at Chicago numbered no less than 15,000; on an average each of these papers was supplied with Exhibition official literature to the extent of 60,000 words a month, more than half of which came back as reprints into the department. These reprints were all classified and pasted up in enormous albums, which of themselves would form an interesting exhibit, and bear admirable testimony to the industry of Major Handy and his staff; not, however, that all these cuttings were collected in the department; on the contrary, "clipping bureaus"—to quote an expressive Americanism—all over the United States, were employed to collect and forward every item published about the Exposition. The average number of letters and other mail packets posted per day in Chicago from this department is about 9,000, and it is stated that the work is increasing even at the present time. Another important branch of labour connected with the Bureau of Promotion and Publicity has been the preparation of more serious and high-class articles upon the Exhibition, for publication in magazines, encyclopædias, &c., and most of the small outline woodcuts which have familiarised the world with the general outward appearance of the principal buildings have also emanated from this department. As to the future, I cannot do better than quote Major Handy's own words: "Up to the opening of the Exposition, and for some time hereafter, probably the department will send out to the Press articles calculated to create a desire on

the part of the people to visit the Exposition, to inform them how best to reach Chicago, and avail themselves of its accommodations. It will endeavour to furnish intending visitors with all information they may need to enable them to do the Fair and Chicago with comfort, pleasure, and the best advantage." All this, however, will form a small part of the duties which lie in Major Handy's immediate future. "The department is about entering upon the task of preparing, editing, revising, and superintending the publishing of the official guides and the official catalogues of the Exposition. This involves an immense amount of careful, painstaking labour. The department is already engaged in the collection of material for the official history of the Exposition to be published by the Government. This is likely to be in proportion about equal to the 'Encyclopædia Britannica,' and must contain much technical and statistical matter." It is quite needless to observe that the active and successful prosecution of all this work has been attended with a very large outlay; the results, however, that have been obtained appear fully to justify the expense. Such a stupendous organisation for advertisement would of course have been wholly unnecessary for any International Exhibition held in Paris, London, or New York, but the organisers of the World's Fair fully realised from the commencement how much the world at large, and even their own countrymen, stood in need of education about the City of Chicago and its resources, and how difficult it would be to make anyone realise the scale of magnificence on which the Exhibition was planned and has been carried out.

Probably nothing has contributed so much to a popular understanding of the extent and beauty of the Exhibition as the large coloured plates that have been issued by the Department of Promotion and Publicity; some of these plates represent the principal buildings, but the most important is a birdseye view of Jackson-park. Although their production must have been very costly, they have been distributed with a lavish hand all over the world, and they prove conclusively that in this particular branch of art printing, Chicago can hold her own against any city in Europe.

13. *Building Materials*.—The materials which enter almost exclusively into the construction of the buildings, are steel and iron, timber, and fibrous plaster; this last-named was used on a large scale and with great success at the Paris Exhibition of 1889. All the elaborate architectural decorative effects are produced in this material, and it may be readily imagined how large a staff of skilled art workmen have been employed. Statuary, moulding, and miscellaneous ornaments have been made on the grounds, although sculptors and modellers have been kept busy, not only in the United States, but also in Europe. At first this art work was produced in a special atelier, but as soon as the Horticultural Building was sufficiently advanced it was converted into an art workshop of magnificent proportions. Especially beautiful will be the monumental fountain of the American Republic, executed by McMonnies, of New York, and referred to elsewhere.

The foundations are almost in all cases of the true Chicago type—that is to say, they consist of broad platforms, whose areas vary with the weight they are to carry, placed at suitable intervals, and entirely independent of each other. The nature of the ground renders this arrangement a desirable one, but whereas in the permanent buildings of Chicago these foundation platforms are constructed of steel beams and concrete, in the temporary buildings on Jackson-park, timber is substituted for steel, and the concrete is chiefly omitted. In preparing these foundations the ground is excavated to the desired depth, and levelled to receive a close-planked platform of the requisite size; on this platform heavy timbers are piled in tiers at right angles to each other, the whole being bolted together, and when the necessary height is reached the foundation is finished by close planking laid to receive the superstructure, whether timber or iron. In some few instances, such as the Administration Building, piles have been driven beneath the main supports of the great rotunda, but the foundation just described may be accepted as the general type. Within the space inclosed by each building, similar foundations are laid at frequent intervals to carry the flooring, and it may be mentioned in this place that very great advantages, as regards expedition in erecting the buildings, were obtained by finishing the floor of each before the heavy superstructure was commenced. A firm and heavy platform was secured by this means, and the amount of damage done to the floor was not so great as might be imagined. The exterior walls of the buildings (with the exception of the Fine Arts) and most of the internal framing, are of timber; as regards the exterior, the main framing, is covered with light timbers nailed diagonally in place, with narrow spaces

between them to serve as a key for the plaster. The external and internal surfaces are carefully rendered upon the coarse internal body of plaster, and the enrichments, prepared as already described, are then added. In the majority of cases timber stanchions serve to carry the iron and steel roofs; in one or two instances, notably in the Fine Arts Building, and in the Mines snd Mining Buildings, iron columns are used; in others, such as the main roof of the Manufactures Building, and in the Electricity Building, the arched ribs start direct from base-plates laid upon the timber foundations; in other cases, again, such as the Administration Building, the dome of the Horticultural Building, and the Government Building, the standards form a continuous structure with curved ribs supporting the dome. In all cases the leading characteristic of the iron and steel work is its remarkable lightness. It is also noticeable that the same types of construction run through, not only every building, but in all the different members in each building, from the vast ribs of the Manufactures Building, to the light purlins and small connecting girders. The type is that of open lattice, the dimensions of which are cut as fine as prudence will allow, while any apparent deficiency in strength is fully compensated by elaborate systems of cross-bracing, It must be remembered that, although these buildings have to serve only a temporary purpose, the material employed in their construction will be called upon to fill other permanent uses, and that during the eighteen months of their existence at Jackson-park they may have to withstand strains as great as if they were intended to last for twenty years. The engineers of the Exhibition had therefore to design work which should really be of a permanent character. There is no doubt that the special and uniform type of construction they have adopted contributed very largely to the rapid execution of the iron work by the various contractors entrusted with its execution. Such contractors in the United States enjoy a well-deserved reputation for turning out work of high character with great rapidity. An illustration of this recently came within my notice. A certain railway in a South American republic was urgently in want of some extensive bridge work to complete a line and convert it into a revenue-bearing property. Tenders were asked for from English and from American bridge constructors, the urgency of speedy delivery being insisted on in each case. The English tenders—which, by the way, were somewhat higher than the Amercan — undertook delivery in eight months; the American constructors offered to deliver within eight weeks. Needless to say, the latter firm obtained the order, and fulfilled it. This little illustration explains other things besides the rapidity with which the ironwork of the Columbian Exposition has been completed. Of course the various buildings were erected by different contractors, so that the whole work could be pushed forward simultaneously; and as three shifts of men were constantly employed, every hour in each twenty-four was utilised. The Art Building, on account of its more valuable contents, has been constructed with a special view to its safety from fire. In this case steel is employed throughout, with outer and inner walls of brickwork. It may be mentioned here that in all cases the specifications in which the tenders for the ironwork were prepared, are as rigid and carefully drawn as for any first-class and permanent building. The exterior and interior surfaces of all buildings are covered with paints of fire-resisting compositions, and the vast areas to be covered suggested to the fertile American mind some device more rapid than the brush, by which the paint is applied by a spreading nozzle, through which it is forced by the agency of air compressed by an electric motor.

It may now be convenient to describe rapidly the distinctive features of the various main buildings; these were referred to prospectively in the paper read last year before the Society; and those remarks may be supplemented now by some facts drawn from the actual work done.

14. *Administration Building.*—The Administration Building is placed at the west end of the great court formed by the long range of façades of the principal halls; it faces eastward, and looks towards the lake. The architect is Mr. Richard M. Hunt, of New York, President of the American Institute of Architects. Its estimated cost is £110,000, and its dimensions are very large. It occupies an area of more than 250 ft. square, and the general design consists of four corner pavilions, 84 ft. square, connected by four walls, in which are the main entrances. The inclosed space forms a rotunda, 120 ft. in diameter and 220 ft. high. The four great portals, one on each side, are 50 ft. wide. The public will be admitted to various exterior galleries, the highest of which is 200 ft. from the ground within the dome. The corner pavilions will be

occupied as offices for the various departments of the Administration, but the building will not contain exhibits. Immediately in front of the Administration Building will be a monumental fountain, designed by Mr. Frederick McMonnies, of New York. This great fountain, which by night will be brilliantly illuminated with electric light and colours, is placed in a basin 150 ft. in diameter. The lip of the basin is about 10 ft. above the level of the grand basin. In the centre of this fountain will be a ship bearing a triumphal car, with a female figure of Progress seated thereon. The boat will be propelled by six heroic figures, wielding gigantic sweeps; these figures will represent the Arts and Sciences. A winged figure of Fame will be at the bow, and Time, represented by an heroic figure, steers the boat. The highest point of this group will be 35 ft. from the level of the basin, and the distance between the tips of the two sets of oars will be about 60 ft. Around the edge of this basin are sea-horses leaping under their riders' blows. Ingenious sprays of water will form a mist and give animation to the fountain. A large cascade of water will pour from the lip of the basin, and pumps with a very large capacity will serve the fountain.

15. *Machinery Hall.*—The Machinery Hall, which is one of the great buildings in the central court, is 850 ft. long and 500 ft. wide, with an annex of 500 ft. by 550 ft.; the east front faces on the central court, and the north adjoins the Administration Building. Three main galleries occupy the length and width of the area; they are about 130 ft. wide, and are crossed in the centre by a transept of the same width. The roofs of these galleries and transept are, in each case, semicircular, the height of springing of the arch being about 22 ft. from the floor level. Each rib is free to turn on three points—the two bed-plates and a central point at the summit of the roofs. The ribs thus consist of two half arches, connected by a central pin, and constructed of light iron lattice girders of the type already referred to, excepting at the base and the summit of the arch, where solid panels are introduced for the whole width of the rib, which is about 6 ft. At the intersection of the transept, the ribs of which cross those of the galleries at right angles, the former are so spaced as to serve as the base for the rectangular iron framework that rises above the top of the ribs, and form the foundation for three flat domes of 130 ft. in diameter, rising to the height of more than 50 ft. above the ribs. By this arrangement the arched framework of the transept is removed, and its place is taken by the series of three domes, rising to about 130 ft. above the floor. The domes are circular in plan, and the space between the lower boundaries and the corners of the rectangular frame above spoken of, as resting on the arched ribs, is filled in with a flat roof. At each corner of the building is an entrance pavilion, surmounted by a domed roof, and in the centre of the north and east sides there are large entrance porticos, flanked by towers 200 ft. high. Outside the arched galleries just described, and surrounding the building, are flat-roofed courts, framed in timber and sheathed with fibrous plaster. These courts are in two stories, affording an extensive promenade on the ground floor, and a large gallery space above. The longitudinal framework of the iron portion of this structure is very elaborate, and cannot be described in so brief a notice as the present; the roof is, to a large extent, covered with glass, and, so far as can be judged, the arrangements provided for lighting and ventilation cannot fail to be satisfactory. The building was designed with a view to erecting it hereafter as a great railway station, to which purpose it can be admirably adapted. The construction of the annexe calls for no particular comment, nor does that of the power station adjoining. This power station will form probably one of the most interesting parts of the machinery section, as it will contain the boilers, engines, and dynamos for generating all the power required throughout the Exposition—about 24,000 h.p. The various units of this station will constitute exhibits. The adoption of electricity on a very large scale, for driving the machinery in motion, will be one of the new departures at the Columbian Exposition. It will be exclusively used in the annexe, which is framed wholly in timber; but in the main hall, steam will be employed. As in the Paris Machinery-hall, overhead rails will run from one end of the building to the other, and on these travelling platforms will be placed for the convenience of visitors. These platforms will be electrically driven.

16. The area of the Machinery Hall is $17\frac{1}{2}$ acres, which is divided as follows:—

	Square feet.
Main hall	425,000
Annexe	269,990
Total	694,990

This area is not quite so large as that of the Machinery Hall and its annexes at the Paris

(1889) Exhibition. As, however, it is hardly to be expected that foreign nations will require so much space for this class of exhibit in Chicago as they did in Paris, it might have been supposed that the space allotted to American exhibitors would have been sufficient for the purpose. This does not appear to be so, and, according to the report of Mr. L. W. Robinson, the demands for space are altogether out of proportion with what can be supplied. The statement that there are 17½ acres of floor space is in itself somewhat misleading, because from this total many important deductions have to be made. These deductions are approximately as follows :—

	Square feet.
Stairways, restaurants, entrances, &c.	56,990
Foreign sections	175,000
Power plant for engines and dynamos.	112,974
Engines for driving American exhibits	3,000
Deductions for aisles, avenues, and passage-ways	116,675
Total net space for American exhibits.	220,351

It will be seen, from the foregoing figures, that the space available for American exhibits and machinery sinks into really insignificant proportions ; that this is so will be a cause of deep regret and disappointment to those American manufacturers who will be unable to display their specialities with advantage, and also to the numerous foreign visitors, to whom the show of American machinery will be one of the principal attractions. It would seem, indeed, that unless some very extensive annexes be made to this building, the Machinery Hall will be a general source of disappointment, because it will be incapable of doing full justice to that branch of American industry which has made such prodigious progress during the last few years. Six months ago the applications for space represented more than four times the total amount available, and the unsatisfactory problem which Mr. Robinson is called upon to solve, is to satisfy exhibitors who require 900,000 ft. of space with one-fourth of that amount. Those who call to mind the American section in the Machinery Hall of the Centennial Exhibition, in 1876, will remember that it was densely crowded, and yet it covered an area of more than 100,000 ft. greater. It is true that on that occasion exhibits relating to electricity, to transportation, and to mines and mining, were all grouped within the Machinery Hall ; but in 1876 none of these classes occupied a great deal of space. At Chicago a vast building has been allotted to each of these groups, and the prospects are that they will be densely packed with exhibits. When the progress that has been made during the last 18 years in mechanical arts is borne in mind, there is no reason for surprise that the demand for space is far greater than the supply, and it would almost appear as if the organisers of the Exposition had lost sight of the fact that the pressure in this department will be unprecedented. Mr. Robinson, the chief of the department, writes at a recent date in a somewhat desponding tone as follows :—" Either three-quarters of the applicants must be left out, or cut down to one-fourth of the space applied for, or finally the chief of the department must take upon himself the responsibility of placing on the space available the representative firms who have applied, and eliminate the less consequential applicants. Thus the manufacturers of the country will suffer greatly by not being able to make as full a display of their products as they would otherwise be entitled to do, and there will be many strong and enterprising concerns who will not be represented. Unless additional buildings are provided, the whole brick and tile industry will not find a place, nor will fire-engines and fire-extinguishing apparatus secure a location. Besides these, heavy machinery, like drop hammers, steam hammers, and machinery requiring fire for its operation, like forges, special boilers, gas and oil machinery, must be omitted."

17. *Agricultural Building.*—This building will be devoted to the exhibition of agricultural implements and processes, and of food products. It is 800 ft. in length by 500 ft. wide, and its façade has been planned to harmonise with those of the other buildings on the main court. It is not a lofty building, its general cornice line being only 65 ft. above the ground ; its general architectural features are a great rotunda forming the principal entrance, and four large corner pavilions connected by a lofty colonnade. The rotunda is 100 ft. in diameter and 130 ft. high ; this rotunda is roofed by a flat dome heavily enriched with mouldings and colour. Apparently the Agricultural Building is not well fitted for the effective display of exhibits. Two central galleries, 95 ft. in width, intersect each other on the longer and shorter axes of the building ; these are roofed by iron trusses of the usual light construction, and being 75 ft. high, these two galleries will be extremely effective ; the remainder of the space is, however, divided up into narrow spans of about 25 ft., with the exception of two of 48 ft., and as all these are wooden structures, with

numerous and heavy posts to carry the roof, the general effect cannot be very satisfactory. The effect of size will be further interfered with by the numerous galleries, about 25 feet above the ground, introduced into most of the narrow spans; it will probably be found difficult to light the interior of this building satisfactorily. But if the interior of the Agricultural Building should leave anything to be desired, the beauty of its exterior cannot fail to attract universal admiration. The whole internal space of this building will not be devoted to exhibition purposes. The agricultural interests in the United States are so vast that it was considered desirable to provide special accommodation for the various farmers' associations, which are very numerous and important. Accordingly, space has been reserved for a suite of committee rooms and information bureaus on the ground floor; while above is a spacious assembly room for agricultural congresses. The building does not represent by any means the only allotments for agricultural interests. There will be various annexes for dairy and forestry exhibits, saw mills, the leather industry, &c., and in this connection I am glad to say the London and Provincial Dairy Company, of which Mr. Watts is the managing director, is erecting a very beautiful pavilion, in which the most advanced processes and machinery of dairy farming will be represented. I, for one, shall be much disappointed if this exhibit does not take a front rank amongst all the similar industries of the United States. A very large open area will be devoted to the exhibition of cattle, and there will be a great covered arena for the same purpose, while long rows of shedding will provide ample and suitable accommodation for live stock which will be brought to Jackson-park.

18. *Electricity Building.*—The chief external feature of the Electricity Building, which is 690 ft. long and 345 ft. wide, is a number of high and ornate towers, which are framed in timber, covered with plaster. Internally it possesses no very striking features, though the central aisle and transept are of considerable dimensions. They are 115 ft. wide, and the trusses carrying the roof are 112 ft. in height. These trusses are open-braced steel-work, starting from the ground with a vertical outer member for a height of 75 feet, while the inner member is curved almost from the floor-line to the centre of the truss overhead. Above the 75 ft. just mentioned the outer member is straight, and inclined to the maximum height of 112 ft. The trusses are placed 23 ft. apart, and the intersection of the nave and transept are made of diagonal ribs of the same character as the others. The rest of the building is covered with a flat roof, supported on deep timber trusses of 23 ft. and 66 ft. spans, the whole floor area on each side of the central aisle being broken up with timber columns placed 23 ft. apart. These all carry the upper gallery, while a certain number are extended to support the timber roof trusses.

The net space available for exhibits in the Electricity Building is 185,000 square feet; of this 68,000 has been allotted to foreign countries, leaving less than 120,000 ft. for American exhibitors, apparently a very small and insufficient area for the proper display of an industrial science which has, during the last ten years, made such enormous strides in the United States. The principal groups will approximately occupy the following areas: Dynamic electricity, including station work, 40,000 square feet; railways, 20,000; mining, 5,000; telephones and telegraphs, 7,000; power transmission, 6,000; miscellaneous, about 40,000 square feet. These spaces will be divided amongst 700 exhibitors, and there will be approximately 300 foreign exhibitors, bringing up the total in this building to 1,000. Collective exhibits will probably be more frequent in the Electricity Building than in any other part of the Exhibition, so far as the American section is concerned; in this section there will probably be not more than 300 separate groups. This arrangement presents many advantages, one of which is economy of space, and that this was an absolute necessity is shown by the fact that the serious applications for space amounted to more than 500,000 ft., or nearly five times as much as could be given. One especially interesting feature in the American section will be a number of personal exhibits made by famous living electricians, who will in many cases conduct a series of experiments connected with their special lines of research in public during the course of the Exhibition. Professor John P. Barrett is chief of the Electricity Department. He is specially qualified for this important position by much admirable work that he has done during the 30 years that he has served as electrician to the municipality of Chicago.

The Electricity Building must not be confounded with that devoted to the generation of power to be employed in lighting the buildings and grounds, and for the transportation ser-

vices. This installation forms part of the machinery hall, and will be largely under the charge of Professor Barrett, who, speaking about this installation, says :—"Electricity will light the entire grounds of all the Exposition and all the buildings. By means of electrical power transmitted from a common centre, all the machinery in all the buildings will be operated. Passenger and freight elevators in the large buildings will be operated by electric motors. The only passenger railway on the grounds will be electrical. The omnibus line of lagoon passenger boats will be operated by storage batteries. Ventilation by exhaust fans in the buildings will be conducted by means of electric motors. The spectacular and other fountains upon the grounds will be electrical. Other uses will be made of electricity in minor directions, and small motors will be made to operate an infinite variety of machinery in every department. In these directions Jackson-park will be in reality an immense electrical exposition.

19. *Mines and Mining.*—The architecture of this building is Italian Renaissance. In plan it is simple, and on each of the four sides of the building are placed the entrances, those of the north and south fronts being the most spacious and prominent. The building is 700 ft. long, and 350 ft. wide. To the right and left of each entrance inside, start broad flights of easy stairs leading to the galleries. The galleries are 60 ft. wide, and 25 ft. high from the ground floor, and are lighted on the sides by large windows, and from above by a large clerestory, which extends entirely around the building. The main front looks southward on the Grand Avenue, and northward on the lagoon and wooded island. The principal fronts display large arched entrances, richly embellished by sculptural decoration, emblematic of mining and its allied industries. At each end of these façades are large square pavilions, surmounted by low domes, which mark the four corners of the building, and lighted by large arched windows extending through the galleries. Between the main entrance and the pavilions are richly-decorated arcades, forming an open loggia on the ground floor, and a deeply-recessed promenade on the ground floor level, which commands a fine view of the lake, and inland to the northward and the great Central Court on the south. These covered promenades are each 25 ft. wide and 230 ft. long, and from them access is had to the building at various points. The loggias on the first floor are to be faced with marbles of various kinds and hues, which will be considered as part of the mining exhibit, and be so arranged as to have a marketable value at the close of the Exhibition. The main fronts are 65 ft. high from the ground to top of cornice, and the main central entrances are 90 ft. to apex of pediment. The two-storied portion of the building, of which the gallery forms the upper part, extends entirely around the structure, and is 60 ft. wide. This portion is built of wood and iron combined. The great interior space thus enclosed is one storey high, 630 ft. long, and 230 ft. wide, with an extreme height of 100 ft. at the centre, and 47 ft. high at the sides. It is spanned by steel cantilever roof trusses, supported on steel columns placed 64 ft. 6 in. apart longitudinally, and 115 ft. and 57 ft. 6 in. transversely, thus leaving a clear space in the centre of building 630 ft. long, and 115 ft. wide, with two side divisions, 57 ft. 6. in. wide, and 630 ft. long each, leaving the great central space encumbered with only sixteen supporting posts. The cantilevers are made with pin connections to facilitate erection. The inner and higher ends of cantilevers are 46 ft. apart, and the space between them is spanned by riveted steel trusses, with an elliptical lower chord. These trusses are so designed as to form a clerestory 12 ft. high, with vertical sashes extending the entire length of the central span, 630 ft., this span terminating at each end with a great glass gable setting back 60 ft. from the front ends of the building. The wide spacings of the cantilever necessitated an extensive system of longitudinal purlins of the riveted lattice type. A great portion of the roof is covered with glass. It may be of interest to state that the cantilever system, as applied to roofs, has not been used before on so large a scale. This building will undoubtedly be one of the most successful of the whole series for exhibition purposes.

20. *Transportation.*—This Exhibition is the first at which a large and separate building has been set aside for exhibits relating to transportation; at all previous exhibitions, objects illustrating various means of transport have been found, but arranged in separate groups and various buildings as subsidiary classes. In no country has increased facility of transportation developed progress and civilisation so rapidly as in the United States, and it therefore followed, almost as a matter of course, that a special department and a separate building should be assigned to it. But that this building should cover as much

ground as the machinery hall at the Paris Exhibition of 1889, and that this vast area of 18 acres should be found wholly insufficient for the demand of exhibitors, is a surprising illustration of the interest taken in the subject, and of the determination of those interested to make as perfect a display as possible. The space required by foreign nations in this important department is set forth in the following list:—

	Square feet.
Great Britain	65,748
France	65,748
Germany	40,000
Canada	15,000
Austria	10,000
Mexico	3,000
Spain	3,000
Russia	2,635
Belgium	5,000
Italy	1,500
India	1,000
Netherlands	1,250
Latin America	618
Total	214,499

American exhibitors have demanded 800,000 square feet, which is far more than can be granted, so that in this building, as in every other, a severe cutting down of applications must become necessary. But although so large an area is asked for, the actual number of American exhibitors is in this department only about 800. It is clear, of course, that exhibits of this class, as a rule, occupy a large average of floor space, and when it is stated that the American section will contain between 60 and 70 locomotives, the largest of them weighing nearly 100 tons, and that the exhibits of railway cars and wagons will include some hundreds of different types, it will at once be realised that the railway section of the Transportation Department must occupy a very large amount of room, and be on an unprecedented scale. Cars for street railways, for propulsion by horse-power, steam, electricity, gas, and other motors, will also be very largely represented, and as it is intended that space will be provided to show these vehicles in operation, a special and large area is to be set aside for this purpose. American railway companies are competing with each other in the extent and magnificence of their exhibits. One company alone has secured an acre of space, in which will be displayed every appliance connected with a first-class American railway. Other companies, while exhibiting their latest practice, will also show examples of their earlier appliances, so as to illustrate historically the development of their line. Road carriages of all kinds will also be shown by some in hundreds of examples. Transport by water will be illustrated chiefly by models, although full-sized boats, and especially steam launches, will not be wanting. All the heavier exhibits in this department will be shown on the ground floor, but the extensive galleries will be occupied chiefly by the lighter appliances for transport, among which it is needless to say bicycles and tricycles will largely figure. In this latter group I think there is no doubt that the English will occupy a leading place.

21. One of the special features of the Transportation Department will be a series of historical exhibits, which it is hoped can be made very extensive and complete. This group will be enriched by many interesting objects from this country, as well as from France and Germany, while the United States possess almost an equal number of the earliest illustrations of steam propulsion, both by land and by water. The country is also rich in exhibits of road vehicles dating from colonial times, and doubtless many of these will be found in the Transportation Building next year. At the same time special efforts are being made to induce the owners of relics in Europe to lend them for exhibition. As far as possible, all the exhibits will be arranged in historical sequence, so as to show the gradual development of the various means of transportation. Speaking recently on this subject, Mr. Willard A. Smith, chief of the department, said:—"There is assured, for the first time in history, a thoroughly international exhibition of transportation. It must be remembered that European railway machinery and appliances are so different from the American that, leaving the tariff out of the question, there is no market for them here. American vehicle builders are rapidly controlling the markets of the world, and American shipbuilding is just starting upon a career of new growth and extension. The inducement, then, for the European countries to make this kind of an exhibit was exceedingly slight. Their first response was, in nearly every case, that they would require no space in the transportation department." Subsequent considerations, however, modified this conclusion, with the result that all foreign sections are now of the extent given above, and Mr. W. Smith states that several important countries are now applying for space which it is quite impossible to give them.

22. *The Fisheries Building.*—Although of smaller dimensions than any of the buildings facing on the great avenue, the Fisheries Hall is of very considerable proportions; and, while it does not compare in architectural magnificence with any of those great structures, the building will, doubtless, be one of the most attractive on the grounds. Considerable wealth and freedom of design are being lavished on the moulded decorations of capitals, cornices, and panels, the treatment being highly original, wholly unconventional, and subordinated in all cases to the special purposes for which the building is devoted. The hall is rectangular, with two circular wings detached, except for a covered arcade. The main building is 364 ft. 8 in. in length, and 161 ft. 5 in. wide, with central projecting vestibules, that increase the extreme width to about 200 ft. Each vestibule is flanked by a circular tower 23 ft. in diameter and 61 ft. high. Winding stairs in these towers give access to galleries beneath the pointed roof. The vestibule between each pair of towers is 80 ft. wide, and its axis corresponds with that of the central dome, that forms one of the chief features of the building. This dome is 80 ft. in diameter, and 152 ft. 6 in. in height to the top of the lantern. The dome is 12-sided, and is framed on the square intersection of the 80 ft. aisle and transverse gallery. At each corner is a small tower, and the dome is supported on a series of columns. The building is covered with a central roof about 70 ft. high, and two half spans surrounding it of 37 ft.; the vertical walls between the top of these latter and the springing of the main roof is filled with windows. Most of the framing in this building is of timber or of wood and iron; the trusses are placed, generally, 20 ft. apart, and a gallery 24 ft. above the ground runs round the building. A second gallery, reached by two spiral staircases, runs around the dome, about 70 ft. from the ground. Besides the main structure, the Fisheries Building is completed by two circular annexes, placed symmetrically on each side, and connected to the hall by covered ways. These annexes are exactly similar in design, and help greatly to increase the pleasing and bold architectural effect of the whole structure. They are 123 ft. 6 in. in diameter, and 70 ft. to the apex of the roof, which is surmounted by a flagstaff 28 ft. high. Each annexe is composed of a central rotunda, 59 ft. 4 in. in diameter, surrounded by a lower roof 37 ft. 1 in. wide. The rotunda is carried upon 16 columns, extended from the ground to the springing of the dome, a height of nearly 40 ft. The principals, resting on these columns, and converging to a central casting, are of a very simple form of construction. The tiled roof covering is secured direct to a series of wooden purlins, fastened to the rafters by angle brackets. The roof is also carried on 16 trusses, symmetrical with those of the rotunda. The height from the floor line to the roof springing is 20 ft. 6 in. The framing of the rotunda roof is concealed by a decorated ceiling of fibrous plaster; and, indeed, the whole skeleton is hidden in the same way, the steel stanchions being converted into highly decorated columns, supporting a wall with arched openings, all hidden by lathing and staff. Above this wall is a circle of smaller columns, that appear to carry the roof. In this way the whole structural work is concealed. The arched spaces between the columns are filled in with stained glass above, and clear glass below, for the tanks of the aquarium, and the surrounding gallery is treated in a similar way. Tanks surround the rotunda and the encircling space, a broad path being provided in the latter; the centre of the rotunda is occupied by a fountain. The internal arrangements of the other annex, which will probably be devoted to angling exhibits, will be somewhat different, but the structural details are similar.

23. *The Horticultural Building.* — The ground occupied by the Horticultural Building is nearly six acres. Its design is admirable, and on a scale harmonising with the rest of the Exhibition. The great constructive feature is the central dome, 180 ft. in diameter, and about 140 ft. in height. This dome occupies the centre, and is surrounded by a square court, roofed, and about 30 ft. in height. The main entrance to the building is in the centre of this court, and on each side within it is a wide circular staircase, lighted from a small dome that forms a conspicuous feature in the design. To the right and left of the central court run two galleries: one in the front is 69 ft. wide, and 272 ft. in length; at the rear is a second gallery, which passes behind, but adjoins the central court; it is about 750 ft. long and 50 ft. wide. The latter gallery will thus form a continuous series of glass houses, maintained at different temperatures for varying floricultural exhibits. A clear space, 89 ft. wide and 272 ft. long, separates the front and rear galleries on each side of the dome, and forms two large open courts that will be utilised for horticultural displays. Each court is

inclosed at the outer end by a spacious wing 118 ft. wide and 250 ft. long. Thus the whole building consists of the central dome and its surrounding covered court; of two spacious end wings, connected with the central court by a gallery in front and one at the rear, these galleries being spaced far enough apart to inclose two extensive open courts. A few words may be added about the constructive features. The dome is carried by a number of curved ribs, built of steel of very light dimensions, and of the same general character as has been already referred to. The foundations are of timber, similar to those of which a type has been already described. The ribs supporting the dome are not curved from the floor line, but rise vertically, like a great circle of stanchions within the inclosing court, as far as the level of the gallery running round the dome, 22 ft. above the floor; above this the curving is commenced, and the ribs, converging almost in a semicircle, meet overhead against a ring to which they are riveted. The height of this ring above the floor is about 120 ft. There are 20 of these great ribs in all; they are connected together in various ways, besides the central ring at the top. At a height of 22 ft. above the floor, and again at 37 ft., a series of light girders connects each rib around the circle. Between the upper row of these girders and the crown of the dome, 10 rings of purlins, made of angle-iron and lattice like the ribs, only lighter and not so deep, are riveted to the ribs. Thus the whole surface of the dome is divided into panels, and every panel is braced by diagonal tie-roads. Midway between each pair of ribs, a secondary rafter, curved to the same form as the ribs, is riveted to the purlin, thus further dividing the panels and affording means for attaching the minor framing and sash bars. The front gallery is wholly of wood and glass. The roof trusses are peculiar in consisting of 18 boards 12 in. wide by 1 in. thick, bent into a circular form and lightly braced. The span is 69 ft., and the height to centre is 38 ft. These trusses are placed about 25 ft. apart, The rear gallery, which is much narrower than the front one, is covered with a light pitched roof, and the construction of the wings calls for no particular notice. These wings are not intended for the display of plants in growth, so much as for horticultural and other exhibitions. Glass does not, therefore, enter so largely into the construction of these wings as in those of the other parts of the building.

24. *Fine Art Galleries.*—Great care has been exercised in the design and construction of the fine art galleries, which consist of one main building and two isolated annexes, for all of which the Ionic order of architecture has been selected. The plan of the main building is cruciform, with large courts at the four angles of the cross. Each arm of the cross, constituting a main aisle and a shorter transept, terminates in a great portico approached from without by a stairway, 60 ft. wide at the eastern and western ends, and nearly 80 ft. wide at the northern and southern entrances; the height of the main floor above the ground is about 9 ft. The central aisle and transept are each 100 ft. in width, and are covered with pitched roofs, the construction of which resembles very closely those over the Galeries Rapp and Desaix of the Paris Exhibition of 1889; that is to say, the roof principals are supported at the ends by columns about 65 ft. high, and from these columns to the adjoining wall, a distance of about 20 ft., inclined struts are introduced, forming a continuation of the principal, and so preserving an unbroken angle for the roof. The space formed by the intersection by the aisle and transept is occupied by a rotunda, carried on masonry piers; the span of the dome covering the rotunda is 72 ft. This rotunda is entered through four openings 38 ft. wide, and axial with the aisle and transept. Above the springing of the roof over these central galleries the masonry is carried with a vertical face on each of the four sides, and against these faces the gallery roofs terminate, the dome springing above their level. The lengths of the aisle and transept are respectively 500 ft. and 320 ft., exclusive of the porticoes. Space is thus obtained outside the aisle and the transept for four external courts 200 ft. long and 100 ft. wide; around the two outer sides of these galleries runs an open colonnade that forms one of the principal architectural features of the building. Each of the four courts is divided into eight galleries and a corner pavilion, and numerous stairways are provided for giving access to the upper courts and galleries that extend around the aisle, transept, and rotunda. Although the external architectural effects are produced by timber framing and fibrous plaster, the structure is wholly of brick, stone, and iron, and the columns rest on concrete foundations.

25. Professor Halsey C. Ives, the chief of the Department of Fine Arts, has furnished some very interesting statistics connected with that part of the Exhibition in which he

is specially interested, and in which the curious exception exists that the United States occupies only about one-sixth of the total hanging space within the Fine Art Building and its annexes. It is claimed by Mr. Ives that the collections in the Art Department will be as large and varied and of higher merit than have ever before been collected in America, or, perhaps, in any other country. In all, the applications for space from foreign Governments amounted to 284,000 square feet. As the total amount of hanging space in the whole of the Art Buildings is only 196,400 ft., and as the American section required 34,600 ft. for its own artists, it followed that there were less than 162,000 ft. to satisfy the demands of foreign exhibitors. This somewhat contracted space has been divided between France, Germany, Great Britain, Austria, Spain, Italy, Belgium, Holland, Norway, Sweden, Denmark, Russia, Canada, Mexico, and Japan. Of course, in no case could the demands made be complied with, and in one respect this, perhaps, is fortunate, as it is probable that a more careful selection will be made among the works of art submitted for exhibition than would have been the case had there been no restrictions with regard to space. France has received the largest allotment, and Mexico the smallest, the figures being 29,200 square feet and 1,500 ft. respectively. France, indeed, seems desirous of making an exceptionally good display, and this is not to be wondered at when the close sympathy existing between French and American artists is considered, as well as the fact that French pictures find so ready and profitable a market in the United States. The head of the French Art Department is M. Antonin Proust, and he states that the work of selecting pictures for exhibition is nearly completed. One special feature of the French Court will be a retrospective gallery, and it may be mentioned, in passing, that this will be chiefly furnished from American private collections. The French Government has also given permission for casts to be made of the historical monuments at the Trocadéro, and these are nearly completed. As regards our own art section, which is presided over by Sir Frederick Leighton, it is sufficient to say that there is every reason to suppose it will be in all respects as satisfactory as that which gained so much distinction in the Paris Exhibition in 1889. Greece will send many pictures, but its chief exhibit will be 100 casts of classic sculptures, selected from the best examples in the possession of the Government. In the United States section, American art is to be better represented than at any previous exhibition, and committees of American artists are now at work in New York, Philadelphia, Boston, Paris, London, Munich, Florence, and Rome, with the object of collecting suitable work from native artists residing abroad. These committees form bodies for preliminary selection, and the pictures they approve will be forwarded for exhibition subject to the assent of a national art committee sitting in Chicago. By this means it is expected that for the first time, the exact standing of the United States in the art world will be clearly demonstrated. Another interesting feature of the American section will be the retrospective galleries, filled with pictures painted prior to 1876, the year of the Centennial Exhibition, which was probably the earliest date at which any important collection of works of American artists was made. It is of interest to note the fact that while the collections from foreign countries in the Art Building of the Centennial Exhibition were remarkable for their size and value, and far surpassed anything that had been previously seen in America, they occupied only 76,790 square feet. Next year, as has been already stated, foreign exhibitors will occupy nearly 162,000 square feet, or more than twice as much, and this amount falls short of the space required by 120,000 square feet.

26. *Government Building.*—The Government Building at the Columbian Exposition is a very elaborate and imposing structure. While assuming little actual responsibility, the United States Government has so closely identified itself with the vast undertaking, that the Government exhibit will be fully worthy both of Washington and of Chicago. In my paper of a year ago I gave very full particulars of the exhibit of the Navy Department, which will be arranged within a full-sized model of an American line of battle ship constructed in the lake. This interesting model is now rapidly approaching completion.

The other Government departments will find accommodation within and around the official building, which is 350 ft. wide and 420 ft. long. The dominating feature is a great central rotunda, covered with a dome 120 ft. in diameter, and rising to a height of 150 ft. Around the dome will be arranged the courts of the various departments—those of the War Department, the Treasury, Agriculture, the Post Office, and so forth. The exterior of this building will be of a highly

elaborate character, the principal features being a magnificent central entrance and very ornate corner pavilions. But the chief beauty of the building is the central rotunda, which will be elaborately decorated from floor to lantern, and around which various galleries will run, to which the public will be admitted. This rotunda is framed with sixteen great vertical columns, rising to a height of 115 ft., at which level the dome commences, its framing being a curved continuation of the vertical stanchions. From the top of the dome rises a lantern about 50 ft. in height and 30 ft. in diameter; light will be thrown from this lantern and from the upper part of the dome through the stained glass of an inner ceiling, suspended at the height of 150 ft. above the floor. The exterior walls of the Government Building are framed in timber, but all the interior framework and roofs are of iron.

27. *Women's Building.*—A very full description of this building, and of the nature and scope of its contents, were given in my paper of last December, at which time the structure was practically complete. There is, therefore, no necessity for reverting to the subject, except to say that the American, as well as the foreign committees, composed entirely of ladies, are very energetically occupied with their responsible task.

28. *The Manufactures and Liberal Arts Building.*—The largest and most important building of the Columbian Exposition, that of the Industrial and Liberal Arts, remains to be described. It covers under its roof no less than 30½ acres, and the estimated cost was £200,000. The contents of the building will be very varied; they will include the exhibits grouped under Department H (Manufactures), Department L (Liberal Arts), and Department M (Ethnology, Archæology, &c.). Department H comprises all branches of manufacture; Department L includes education, literature, engineering, public works, music, and the drama.

The plan of this great structure is rectangular; its vast area is enclosed on all four sides by courts in three spans, one covered by an arch 101 ft. wide, and on each side of it by a lean-to roof of about 50 ft. These galleries surround a great central court. In the earlier design of this building it was intended to preserve the greater part of this inner court as an open space, broken in the centre by a dome-covered rotunda of nearly 400 ft. in width. But two reasons brought about a change in this plan. In the first place, it was evident 18 months ago that this court would be needed for exhibits under cover; in the second, the whole scheme had so grown in the hands of the organisers, that it was considered necessary to have one vast monumental building, the size of which should be greater than had ever before been attempted. The court inclosed within the outer galleries presented just the conditions for supplying these requirements, and it was therefore determined to cover it with one clear span of larger proportions than had been ever attempted before. Before proceeding to describe this, the most striking engineering work of the Exhibition, a few words should be given about the general characteristics of the building. The leading exterior architectural features are those common to the other large buildings—arcades running round the structure, and contained within the narrow outer gallery before referred to; these arcades afford a spacious and convenient promenade on the ground floor, and an admirable exterior gallery above. In the design of such vast buildings as these, especially where the plan is necessarily of quite an elementary character, it is extremely difficult to judge of the architectural effect from drawings. On paper, the repetition of a long series of arches becomes monotonous, and the more striking features, that may prove admirable in execution on so great a scale, are apt to leave a disappointing impression when drawn on paper. This impression may possibly be produced by an inspection of the designs, especially when taken in connection with the plain pitched roofs over the arcades, and the enormous domed structure above. In execution, however, the appearance will be wholly different, and it is only necessary to recall the contrast that existed between the plan of the great machinery hall of the Paris Exposition of 1889, and the actual structure, to realise that the Industrial Hall at Jackson-park will not suffer by comparison with its smaller prototype on the Champ de Mars. An inevitable penalty, however, must be paid for these heroic dimensions; every one will remember how, in 1889, the span and height of the machinery hall dwarfed the exhibits, and this will be still more apparent where dimensions are far larger, and the show-cases of the industrial exhibitor will usually be of less imposing appearance than the contents of a machinery hall.

The Manufacturing and Liberal Arts Building consists of a great central hall 1,268 ft. in length, and 386 ft. in clear span; the height

of this hall from the floor to the under side of the roof girders is 206 ft. 4 in. clear, and to the top of the ventilating lantern, 245 ft. 6 in. This vast roof is supported on 18 main ribs, spaced 50 ft. apart; these provide for 850 ft. of the 1,268 ft. constituting the hall; the remaining 209 ft. at each end are filled in with a gigantic gable, framed upon two long trusses starting from the extreme corners of the structure, and meeting at the ridge; the curves of these trusses are, of course, projected to suit the sweep of the roof, and to them are framed partial ribs finishing against the gable trusses on each side and at the ends. As nearly as possible the spacing of 50 ft. is maintained for all these trusses. The great roof ribs are hinged at the bedplates and the apex; the intrados of the truss is curved almost from the ground; the outside is vertical for about 100 ft., and tben it sweeps upward to the ridge with a flat curve. The first four bays are braced diagonally, and after that alternate bays, formed by two principals, are braced together. As may be supposed, the roof purlins are formidable structures, and three tires of longitudinal girders connect the trusses in the 100 ft. space formed by their vertical ribs; the building is surmounted by a high and wide lantern; the unglazed part of the roof is close boarded, and the exterior covering is sheet iron.

As stated above, this great hall is surrounded by what in comparison are quite insignificant structures, but which, nevertheless, are of considerable dimensions. They are provided with galleries that in the inner span are extended inside the great hall between the trusses; although these galleries look very low, they are more than 20 ft. above the ground, and they are sufficiently extensive to give a large additional area for exhibition purposes. These galleries are connected across the centre span of the surrounding courts by broad and frequent gangways, which also afford considerable floor space.

29. The time available between the inception and the opening of an exhibition is so short that manufacturers have always to pay great attention to the question of erecting the structures in order to complete the work in the period allowed. It must be remembered, too, that, although only required for a short period, the construction must be as strong as if the building were to be permanent. The Manufactures and Liberal Arts Building is an extraordinary illustration of rapid construction. The Edge Moor Bridge Works signed the contract on December 24, 1891, and undertook to complete the work before August 15, 1892, so that they had only seven and a-half months for this immense nndertaking. The method of erecting the roof can be explained without the aid of diagrams. As already stated, each span is pivoted at three points—at the springings and at the apex—to simplify the calculation of the strains, and in this respect the designers followed the example set at Paris. In other points there is a great divergence between the two designs, the Paris arch being a plate girder with a spandril filling, instead of a light braced structure. The systems of erection were also dissimilar, as might have been expected. In the matter of dealing with large pieces of framed work, the Americans have little to learn from the rest of the world, and this seems clearly demonstrated by the fact that they reduced the time taken in erecting the roof to one half of what was required in France, and which appeared at the time wonderfully rapid. The general plan which was adopted was as follows:—Each half of each rib was built in two sections; from the ground to a point about 100 ft. above the ground—that is, as far as the vertical back of the rib extends—was erected in place, and from that point to the apex, the upper part was put together on a platform erected on a movable stage, and was afterwards hoisted into position and connected to its fellow. The movable staging, or traveller, was constructed of three towers braced together so as to form one structure. The two side towers were each 134 ft. high, and 50 ft. wide from centre to centre of the timbers, measured in the longitudinal direction of the building. The central tower was in two storeys; the lower part was 134 ft. high, like those of the side, but it was extended to a width of 80 ft. by raking side struts. The summit of the second storey was 222 ft. 6 in. high, its upper platform being capable of being lowered when the staging was to be moved. The whole structure was mounted on 28 heavy wheels, 20 in. in diameter, running on eight lines of rails, carried on a timber foundation laid on the floor; its weight was estimated at 350 tons. As the width of the traveller was the same as the distance between the ribs, it became possible to erect two of these latter simultaneously. To allow of its being traversed as the work progressed, its greatest dimensions were somewhat less than those of the contour of the arch, except in the case of the upper tower, which, as said

above, could be lowered. This necessitated the use of very long crane arms for assisting in the erection of the upright part of the arch. Four cranes 62 ft. in length projected from each end of the traveller, and these were operated by two winches of 24 horse-power each with six independent drums.

30. The iron and other materials for erection were brought into the building by temporary tracks, laid on the floor parallel to the staging, and were lifted by the cranes and built into place, the side pieces of the arch being, meanwhile, steadied by struts from the stages and the ground. On reaching a point about 100 ft. from the ground, another system of construction was adopted. The part already completed was firmly connected to the scaffolding by means of adjustable loop-rods and hydraulic jacks. On the higher storey of the central tower were four cranes, each 36 ft. long, worked by a 24 horse-power engine, with six winding drums at the ground level. These cranes were employed to lift the material for the upper part of the arch, and to lay it on trucks running on rails upon the upper platform of the stages. From these it was taken by two smaller travellers running on the upper platform, and laid on a curved centreing built on the platform, and corresponding to the upper part of the arch. The upper half of the rib was connected to the lower half by a pin, that formed a pivot or hinge. Owing to the comparatively light character of the upper parts of the arch, they were rapidly completed. Two adjoining half-arches were then connected together by the purlins and bracing-rods, and hoisted into position from the central tower. As the half-arches overlapped on the false work, one had to be lifted before the other was completed. When this latter came to be raised, it would have fouled its companion just as it was attaining its highest position, and to prevent this, the hinge pins were forced apart from one another by the hydraulic jacks through an additional 3 ft. This allowed ample clearance to get the half-arches into position, and then to allow them to come together and meet on the connecting-pin at the apex. The jacks were then slacked back, until the joints closed and were secured by bolts. The pair of arches then stood firm and safe. Each pair, when completed, weighed about 430 tons, while the weight of each piece lifted from the central tower was 32 tons, ezcept in the case of the end arches, which weighed 40 tons.

When one bay was completed, the traveller was moved forward for erecting the next pair. This was done by means of three 24 horse-power winches hauling on the staging. This operation occupied from 45 to 60 minutes, while lowering and raising the tower, and the miscellaneous work of getting into position, lengthened the time to half a day. The lantern frames, jack rafters, &c., were put in place subsequently by small travellers running on the purlins. It will be readily conceived that the method of working, which was devised by Mr. S. P. Mitchell, assistant manager of the Edge Moor Bridge Works, enabled the erection to be carried out very rapidly, since two arches were always in hand at one time. The first pair of ribs occupied 9 days of 10 hours; the second pair, 8 days; and the fourth pair, 5 days.

31. It will be interesting to compare these times with those occupied in the erection of the spans in the machinery hall at Paris. The work was there divided between the Fives-Lilie Company and MM. Cail and Co. The former put the ironwork together on the ground for each span in four separate pieces, and then raised them into place. The scaffolding consisted of a tall gantry, as high as the middle of the roof, and of two side platforms. These three structures were independent of each other, and ran on rails. The central tower was 72 ft. long, 62 ft. wide, and, 144 ft. high. The width of one bay being 70 ft. 6 in., the gantry was wide enough to include two consecutive girders, while its upper part was formed to the same contour as the underside of the roof. The side scaffolds were also formed to the same contour as the roof, and covered with planking. A considerable part of the arch was built on the ground. Its lower end was then engaged with the bottom pivot, and it was raised into position about that centre. The remaining portion of the half-span was also built on the ground, and then lifted bodily until one end rested over the central staging, and the other end over one of the side stagings. The pieces were then riveted together. The first bay was completed in 23 days, the second in 16 days, the third in 12 days, and the rest in 10 days each. The Cail Company followed quite a different plan. It consisted in constructing a narrow scaffolding, the top of which was the same form as the inner side of the arch. Portions of the girder, not exceeding 3 tons in weight, were riveted up on the ground, and then raised and put together on the staging. The first girder and bay were completed on May 24, 1888, the second girder

and bay were finished in 13 days, as was also the third; the fourth and fifth were completed in 12 days; the remainder took 10 days each on the average. It will be seen that the work at Chicago has been done with unprecedented rapidity. In 7½ months detailed drawings were prepared; the steel and iron work constructed, and transported nearly 1,000 miles; and about 7,000 tons erected.

32. From the foregoing description some idea will be gained of the internal appearance of this vast building. The side galleries that surround it, extensive though they are, are of necessity dwarfed into comparative insignificance by the large dimensions of the Central Hall, and there is little doubt that the imposing appearance of the exhibits will also suffer from the same cause. And yet, as was the case with the machinery hall at the Paris Exhibition of 1889, it will be difficult for the visitor to estimate, by the sense of sight, the size of the building. It will be only by the experience of fatigue that he will understand its size, after he has devoted many hours or days to the examination of its contents. The main passages for circulation will be a path 50 ft. wide, running from end to end down the centre of the building, and called Columbian-avenue, while another of similar width crosses it at right angles on the shorter axis. The intersection of these avenues will form a central open space, upon which will front the four courts of the most important nations exhibiting—those of the United States, Great Britain, France, and Germany. It does not come within the scope of the present paper to attempt any description of the probable contents of this building. Nearly the whole of the ground floor will be devoted to manufactures, a comprehensive term that includes the product of innumerable industries. It will be in this building that English visitors interested in, or fearful of, the industrial progress of the United States will be able to form a fairly accurate estimate of the capacity for production, and the quantity of the output, of the country we are beginning to regard as our chief competitor in the near future. No similar opportunity has been offered since 1876 at the Centennial Exhibition, and that is now almost a prehistoric period in the history of commerce. The displays that America has made at subsequent foreign exhibitions have afforded no measure of her power, and it is for this reason that the American section of the Manufactures Building will prove of the highest interest to ourselves.

33. Another collection of the highest importance, though not so directly bearing on financial interest, is that which gives its second name of Liberal Arts to the building. Judging from what Dr. Peabody, the chief of this department, has written at a very recent date, commercial interests have been too great for those of liberal arts, which have suffered accordingly from want of space. It was at first intended that a large part of the space should be devoted to the latter department, and when it was found that the demands of manufacturers were so great as to fill a building four times as large, there was an effort made to have a separate hall erected for the liberal arts. This was found, however, to be impracticable, and by patient and consistent compression, the liberal arts will be accommodated under the same roof as the manufactures. On this subject Dr. Peabody writes:—"The interests confided to the Liberal Arts Department are those of education, science, literature, and the whole circle of the arts. For six months the decision wavered in the balance whether this department should have provision for its needs proportioned to that granted to the other departments of the Exposition. Under great pressure, three-eighths of the space once accorded to it have been assigned to others, and the persistent efforts which its friends have so earnestly made have been not to add to its facilities, but to in some measure restore those which had been taken away." It is yet hoped that this pressure may be reduced by the erection of an additional building for educational exhibits, but the prospects of this extra accommodation are very slender. A few figures furnished by Dr. Peabody will show how large and important a section that of education will be if sufficient space can be provided. With regard to foreign countries, France and Germany ask for 60,000 square ft. of space, and the British Liberal Arts section should occupy the same amount; the Roman Catholic Church applies for 60,000 square feet for its educational exhibits; and in the United States more than ten times that area, or 650,000 square feet, are asked for by 1,100 different applicants, in 41 States and territories. Most of these applicants are the leading universities, colleges, and schools of America, and many of them propose to send very elaborate and complete exhibits, illustrating their system of general and technical training. Collective exhibits are also being arranged by commercial colleges, manual training schools,

art schools, educational establishments for the mentally and physically afflicted, schools for Indians, &c. It is intended, if the scheme is found practicable, to show a number of different classes in active operation, so that the various systems of training may be properly illustrated. Altogether about 325,000 square feet of space will be required for the American group of educational exhibits, which will represent the training of 14,000,000 American children and students by 500,000 professors and teachers. The various colleges and schools are spending at least £100,000 in preparing for this exhibit. Of other branches of the liberal arts, the space demanded for hygiene and charitable institutions is 30,000 square feet; for medicine and surgery, 20,000; for books and literature, 35,000; for physical apparatus, 25,000; for photography, 10,000; for engineering and architecture, 10,000; for social and religious organisations, 10,000; and for musical instruments, 100,000 square feet. This last group, it is intended, will be of great interest and importance. It will include an historical loan collection, and is under the special charge of the Bureau of Music, which will control the entire musical arrangements for the Exposition. The group will be exhibited on the ground floor of the Manufactures Building, a location having been assigned to it near the Music and Concert Hall. The other objects of the Liberal Arts Department, except education, will be displayed in the spacious galleries on one side and part of each end of the building. Space for these groups will be thus provided; it is only the educational exhibits which at present are in danger, and which appear certainly likely to suffer almost to extinction if the demand for a special building cannot be complied with.

34. *State Buildings.*—The various States and Territories have contributed collectively large sums for the erection of buildings, and for the exhibits which will be placed within them. These buildings occupy a large area on the north side of Jackson-park; the principal of them is appropriately the building of the State of Illinois, which will cost £60,000, and which is 450 ft. long and 160 ft. wide. In the centre of this building there will be a lofty rotunda covered by a dome, which will be a conspicuous object throughout the grounds. Around it will be distributed the offices and head-quarters of the Governor and other State officials, and in a fireproof annexe will be displayed the various relics and trophies belonging to the State. It will contain a large collection of objects illustrating the natural resources of Illinois, and the various State departments will have special allotments. The more important of these will refer to the common and higher schools, charitable institutions, and agricultural products; the geology, botany, and zoology of the State; architectural drawings of every public building in Illinois, and a large number of other objects. It would occupy too much space to attempt a description of the numerous State buildings; some few particulars may, however, be given. The California Building, with its exhibits, will cost £15,000. It will be in part the reproduction of one of the old Spanish missions, the remains of which are plentiful in California, and which were founded 120 years ago by the Roman Catholic priest, Junipero Serra, who for many years devoted his life to missionary work upon the Pacific coast. The building of Colorado, which is nearly finished, is an elaborate structure of native granite and marble. The State of Connecticut raised £10,000 by private subscription for its building, which is nearly finished. The building of the State of Florida, extremely primitive in appearance, is of great historical interest. It is the reproduction of the original Fort of St. Augustin, which, with the town of that name, was founded by the Spanish in 1665. Since then it has been the scene of many a bitter fight between the Colonial troops and the Spanish, prior to the cession of Florida to Great Britain in 1763, when it was exchanged for the island of Cuba. The State of Georgia raised £20,000 by private subscription, but its building has not yet been commenced. That of Indiana is constructed wholly of native material, but will cost only £5,000. Iowa is devoting £10,000 to its building, which is well advanced. Kansas, although it obtained £20,000 by private subscription, is spending only £4,000 upon its pavilion, which is nearly finished. The State of Kentucky will have a building costing £20,000; and the almost completed pavilion of Maryland, which is built of granite, will cost £7,000. The State of Michigan is spending £10,000 upon its buildings, which will be constructed wholly of native material. That of Missouri, although one of the smallest of the series, is to cost £10,000. Montana has a fund of £20,000 for its building and exhibits. Nebraska only collected £10,000, and New Hampshire £5,000. The Government of New Jersey appropriated £14,000, and will have a fine pavilion, which is well advanced. North Carolina and Dakota

each subscribed £5,000. The States of Ohio and Oregon have funds of £20,000 at their disposal, and their pavilions will make a very much finer appearance than that of Rhode Island, whose pavilion will only cost £600. South Dakota raised £16,000 by public subscriptions, and its extensive building, which will be the reproduction of an old-fashioned French farmhouse, will be very striking and picturesque. Vermont only secured an appropriation of £5,000, so that its building will be a simple and modest one. The State of Virginia is spending twice that amount for its pavilion, and Washington is devoting about the same amount to this purpose. The most original of all the State buildings will be that of Utah, which will be constructed of salt, and which will cost £10,000. Wyoming will restrict itself to a club-house of very modest dimensions, costing £4,000. The building of New Mexico will cost £15,000. The pavilion of Louisiana will represent a typical southern house, and will cost, with its exhibits, £10,000. The State of Maine will be represented by a sufficiently spacious club-house, which, as it is constructed of native granite conveyed for nearly 1,000 miles, appears cheap at £2,000. Massachusetts spends four times that amount in the reproduction of a famous old Boston house, which was erected in 1737. The pavilion of New York State is also historical, as it is the reproduction of the famous building once occupied by Van Rensseler, who figured prominently in the Dutch period of New York's history. New York State made an appropriation of £60,000, and the appropriation of Pennsylvania was for the same amount. The Pennsylvania building will, after that of Illinois, be probably the most important in the grounds. It will occupy in all the space of 18,000 square feet, and will reproduce the general features of Independence Hall of Philadelphia, especially the historic clock tower, and the bell which tolled the knell of British rule in America, and rang in the birth of the new Republic. This bell will be hung in the clock tower of the Pennsylvania Building at Chicago.

From the foregoing summary it will be seen that these buildings, which will in all cost about £300,000, will make a beautiful and varied show. So also, at a less extent, will the pavilions of foreign nations. That of this country, in which we are most interested, will doubtless be worthy of the beautiful site allotted to it on the shore of Lake Michigan.

35. *Previous Exhibitions.*—It may be of interest to make a few general comparisons between the forthcoming Columbian Exposition and its principal predecessors. Beginning with the first great World's Fair that was held in Hyde-park in 1851, and was the forerunner of the long series which at short intervals has delighted the public and harassed the manufacturer, we find that it was held in a building 1,851 ft. in length and 450 ft. in width. One of the buildings in Jackson-park, that of the Manufactures and Liberal Arts, is 1,687 ft. in length and 787 ft. wide; this build-alone could have contained the Exhibition of 1851 within its walls; but this early exhibition was not only the most marvellous, but also the most successful that has ever been held, for it closed its doors with a net profit of £150,000, a result which has never been reached at any subsequent exhibition. It was remarkable also for the large number of exhibitors crowded within the narrow space, the number falling only just short of 14,000, of which, astonishing to relate of that far-off time, more than half came from our colonies.

In 1853 the first World's Fair held in the United States was opened in New York. It covered an area of 263,000 square feet, and it contained 4,100 exhibitors, more than half of whom were foreigners. The total expenses amounted to only $640,000, and the receipts to $340,000, so that there was a loss upon the enterprise of £60,000.

In 1855, the first International Exhibition was held in Paris under the auspices of the French Government. It was for this exhibition that the Palais de l'Industrie was erected, and which alone remains of the numerous additional buildings and annexes, which together covered an area of 1,886,000 square feet. There were in all nearly 24,000 exhibitors, of whom 144 were from the United States. The total number of visitors to this exhibition was 5,162,000, and the largest number of visitors on any one day was 121,000. Passing over the smaller exhibitions of 1854 in Melbourne, of 1857 in Brussels, and that at Lausanne in 1858, at Turin 1856, at Hanover in 1859, we come to the second Great Exhibition held in London in 1862. Its main buildings covered 17 acres, or less than the Machinery Hall at Chicago. The total cost of the buildings was £320,600, and the entire outlay was about £460,300, so that the loss on the undertaking amounted to £140,000. The visitors to this exhibition were 6,210,000, and the largest attendance in any one day

was almost exactly one-half of that at Paris in 1855.

The second Great Exhibition in Paris was held in 1867, the principal building of which covered 11 acres; the Champ de Mars was, however, crowded with a large number of annexes and small structures. There were no less than 52,200 exhibitors, and a total of 10,200,000 visitors was recorded. The gross receipts amounted to about £400,000. The Great Exhibition of Vienna, held in 1873, was rendered an unfortunate failure by the visitation of cholera in the city that year, and which was the cause of the small number of visitors which attended it. The municipal guarantee loan and the Government loan together produced the capital of £900,000, and the buildings were the most extensive and elaborate that had been built for such a purpose up to that time. The main building was no less than 2,953 ft. in length; it was intersected by sixteen transepts, each 573 ft. long, and in the centre of the building there was a gigantic dome 354 ft. long. Agricultural exhibits were held in a separate building covering 6 acres, and the Machinery Hall occupied an area of 10 acres; the Art Building, a very beautiful and elaborate structure, was 600 ft. long and 100 ft. wide. The Centennial Exhibition, held in Philadelphia in 1876, was intended originally to be only a national exhibition; at the almost unanimous desire of European countries it was converted into a World's Fair and largely extended. The necessary funds were raised by public subscriptions all over the United States; by a loan from Congress of 1,500,000 dols., a present by the City of Philadelphia of 1,000,000 dols., and another gift by the State of Pennsylvania of 1,500,000 dollars. The exhibition was held in Fair Mount Park; it occupied 285 acres of ground; the buildings were numerous and some of them beautiful, especially the Art Gallery, which remains as one of the monuments of Philadelphia to-day. There were 30,864 American exhibitors; Great Britain and the Colonies contributed 3,584 exhibitors, and Spain was largely represented with 3,822. Altogether 32 foreign nations took part in this exhibition, which was visited by 9,911,000 people; the greatest number of visitors in any single day was 275,000.

The Paris Exhibition of 1878 was held in the Champ de Mars and in the Trocadéro; the main buildings covered 54 acres, but, of course, this was largely supplemented by a great number of annexes and special buildings. There were 52,835 exhibitors, of whom 25,872 were French, 3,184 British and Colonial, and 1,203 American; the total number of visitors was over 16 millions, and the receipts were about £500,000. As the Exhibition cost was nearly $2\frac{1}{4}$ millions, there was a loss on the undertaking of £1,716,000, but of course the city of Paris benefitted largely by the immense crowds that flocked to the city during the year. The Great Paris Exhibition of 1889 appeared to everyone to have reached the highest point of which exhibition development was capable. The amount expended on the buildings and grounds was considerably over one million sterling; the number of visitors exceeded vastly anything that had been obtained at any previous exhibition, and attained the stupendous figure of nearly thirty millions. This was only reached by the ingenious operation of issuing Government lottery bonds, to which entrance coupons were attached, to the public in such large numbers that the value of the coupons was reduced, during some portion of the exhibition, to one-fourth of their value.

The area of the Columbian Exhibition ground is 666 acres; this is crowded with buildings to the extent of over 200 acres, the cost of which considerably exceeds two millions sterling, while the total expense is estimated at between four and five millions. It is too early to form any estimate of the number of exhibitors who will find space, and it would be a waste of time to speculate as to the probable number of people who will visit the Exhibition next year. It is hoped, of course, that this will exceed the total made in Paris in 1889, but it appears hardly likely that such a result will be achieved, considering the high price charged for admission, and the restricted privileges that will be accorded on Sunday, even if visitors are admitted at all on that day. In any case it is almost too much to hope that the Columbian Exposition will prove a direct financial success, but that is a matter of infinitely small importance compared with the enormous pre-eminence and indirect benefits that will accrue from it to the City of Chicago and to the United States.

36. *Conclusion.*—This is not the occasion, nor am I sufficiently acquainted with the subject, to dwell on the great and unexpected political event which, on the 9th of last month, took the whole of America and Europe by surprise. I think the annals of United States history do not furnish a precedent for such an

overwhelming expression of opinion of the national will. As to the cause which brought a party into power whose popular motto is "Protection for revenue only," I know little or nothing. We are told by the newspaper organs of the triumphant party, that it is a protest by the most intelligent voters in the world against an exaggerated system of Protection, which created monopolies, and benefited the capitalist at the expense of the working classes. On the other hand, Republicans attribute their defeat to one of these inexplicable attacks of mental alienation that occasionally sweep over a nation at critical periods. I suppose that the general feeling in Europe is one of satisfaction at the prospect of a modification involving great reductions in the present tariff, which has already borne hardly on many of our industries. And it is probable that if this Presidential election, with its strange result, had taken place a year ago, the applications for space at the Columbian Exposition, from our manufacturers and from those of the rest of Europe, would have been far more numerous. As it is, those who were enterprising enough to devote time, money, and trouble to help swell the great display at Jackson-park, will feel more hopeful of the result of their venture; and at present there is a general belief that the time is not far distant when the United States shall again prove to be an almost open market. It is certain that the Democratic triumph, generally construed as a popular protest against extreme protection, has met with hearty, though perhaps not disinterested, sympathy in this country, and that much of the indifference, and even hostility, displayed against the Chicago World's Fair will be exchanged for active interest and sympathy. There cannot be more foreign exhibitors, for there is no more space to be allotted, but if all be well there will certainly be more visitors from Europe.

I think it will be found, after the Exhibition is over, that their American hosts have treated British exhibitors with more than usual courtesy and generosity at Jackson-park. The free permission to attach labels bearing sale prices at the place of manufacture, is a proof of this. This was a privilege absolutely refused at the Centennial Exposition of 1876, when tariff laws were less oppressive, and competition had scarcely begun. The value of this privilege is indeed very great, considering that the display of prices free of duty will carry a striking lesson to the minds of the masses eager for proofs to justify their recent political action. It will also prove of of the greatest benefit to British exhibitors, because it will vastly increase the chances of transacting business with foreign buyers over the heavily handicapped American manufacturer.

It must be borne in mind that a great International Exhibition is not planned and brought into existence at a vast outlay for sentimental purposes. Still less is it held in any country for the benefit of foreign manufacturers. An exhibition cannot be international without the co-operation of foreign nations, but, setting aside its good effects as a popular educator, and the incalculable benefit of healthy but severe competition, the main object of the country holding it is, as far as possible, to increase its foreign trade, at the expense of other countries. The ideal International Exhibition—no matter where it is held—would be one to which foreign nations would contribute in such a way as to add to its beauty, completeness, and value, without interfering with its anticipated commercial advantages. But, on the other hand, exhibitors will not incur all the expense and trouble of participation without the hope of profit, and without the prospect of maintaining their existing business, and making new connections. On both sides these objects are wholly praiseworthy, and entirely antagonistic, and bearing in mind that one of the chief ambitions of the American nation is to extend their foreign trade, I think the grant of full privileges of pricing exhibits is a most generous concession to our exhibitors, and indicates clearly the good feeling that exists towards us.

I trust that the experience of a large number of Englishmen during the next year at Chicago will do much towards strengthening this good feeling, which can always exist even in the face of the fiercest competition, and that a year hence I may once more have the pleasure of addressing you on the subject of the Exposition, and on some of the lessons which it has taught, after it has become a thing of the past.

DISCUSSION.

The CHAIRMAN said he regretted that a previous engagement had prevented Sir Richard Webster from being present that evening, and he would first call on Mr. Biddulph Martin, one of the Commissioners, who had been present at the dedicatory ceremonies in October.

Mr. J. BIDDULPH MARTIN said he had very little to add to the very instructive paper they had heard, but he must be allowed to say that even the excellent photographs which had been shown did not entirely convey the idea of the enormous amount of work which had been got through in the construction of these buildings. He had the opportunity of driving through the main building in May, when it had no roof on, and also formed one of the 100,000 people who were present on the 22nd October, at the dedicatory ceremony, when the building was practically complete. As a statistician, he could not help referring to figures, but he would only mention one or two which had not yet been given. The separate buildings over there were not known by the long names given to them in the paper, but by their size—the one devoted to arts and manufactures being known as the 30-acre building; its flooring took 17,000,000 cubic feet of timber to construct, that being the product of 1,100 acres of Michigan forest pine. At the opening ceremony 90,000 chairs were put in rows for the accommodation of the spectators, even the most favoured of whom were unable to hear a word of what was said. Above their heads were the stars and stripes, displayed on banners 90 feet long, and he understood that the fabrication of these flags was a matter of great difficulty, but anything less would have looked ridiculous. He was received with the greatest possible hospitality on all sides—by the chiefs of departments and by all the *employés*, including the numerous staff of lady clerks, who formed so important a part of any large undertaking in America. This courtesy was extended to him not on his own account, nor entirely because he was a member of the Royal Commission, but because all wished to show the great value they attached to the cordial support of Great Britain. They said, and he believed it to be the fact, that they appreciated most highly what they called the "send off" given to the Exhibition Commissioners by England in 1891, which gave the keynote to the whole of the continent, and ensured the adhesion of all European Governments, and the success of the Exposition. They also expressed their feeling that whatever England took hold of was sure to be put through well, and they looked forward to a first-rate exhibit from the British Empire. He trusted that confidence would be justified, for it would not do, from any point of view, for Great Britain to get left, as the Americans expressed it. There was some antagonism, no doubt, to the policy which had lately ruled in America. It was said that they were excluding emigrants, and doing their best to exclude our manufactures by their tariff regulations; but, as Mr. Dredge had pointed out, a great reaction was shown at the recent elections, and there would probably be not a sudden, but a gradual modification of the tariff, which would be an advantage to us. He did not feel certain that it would be an unmixed advantage, but he would not go into a discussion on the question of protection and free trade. A word or two, however, he must say on a very minor matter—nothing like so important as that of tin plates—viz., that of binding twine for reaping purposes. The tariff was put up on that article from 1 cent to 2 and a fraction, and would have gone higher but for the indignant protests of the farmers; and now no doubt it would be lowered. That would enable the farmer to economise slightly in that small article, and if the effect of the Chicago Exhibition were to enable him to obtain his implements and machinery cheaper from England or elsewhere, he would compete very seriously with our already depressed agriculturists. But he believed England would be able to hold her own, and she must do so, for if she did not keep the market others would have it. It was of the greatest importance to our commercial interests to make a good show next year at Chicago, but still commercial competition was not the sole object. There was a broader purpose, that of giving a further object lesson on the well-known text that the triumphs of peace were greater than those of war. It would, he trusted, show that the interests of the British Empire and of America were inseparable, that no discord was permissible, and that strife would be fratricidal. The Exhibition would not only tend to the advantage of the British Empire in its friendly contest with its mighty daughter across the Atlantic, but draw together and bind fast those bonds of mutual esteem, affection, and regard, which united the mother country to the great English-speaking race, whose unexampled privilege it had been to subdue, civilize, and populate all the waste places of the earth.

Sir SAUL SAMUEL, K.C.M.G., C.B., said he remembered being in Chicago in 1873, not long after the great fire, when the new city was rising, but the population was then only about 350,000, whereas it now exceeded 1,000,000. It was marvellous to think what strides had been made in that short space of time. The great colony of New South Wales, which he had the honour to represent in this country, the oldest in Australia, was about to exhibit at Chicago, though, as far as he knew, none of the other Australian colonies intended doing so, and in order to be properly represented were going to expend nearly as much as Great Britain. He believed it would amount to £50,000, the estimate was £30,000, and, as they knew, such estimates were almost always exceeded. The colony was a long way off, and as they had to pay all expenses of transport, the amount required would be great. The Colony, however, as part of the British Empire, felt it her duty to be properly represented. It was very important to the Australian Colonies that their wool should be admitted into the United States at a lower duty than that now imposed, and no greater evidence could be given of the value of free trade than such a desire on the part of colonies which themselves went in for protection. The woollen manufacturers of the United States could no more do without the Aus-

tralian wool than they could without English tin, and they were beginning to see the necessity of admitting it, if not free, at all events at a greatly reduced duty.

The CHAIRMAN, in calling next on Sir Henry Doulton, said he had recently had the pleasure of seeing the exhibit at Lambeth whirh was going to Chicago, and referred especially to the new Crown Lambeth ware, which formed a special feature of the collection.

Sir HENRY DOULTON said what had struck him most in looking at the views thrown on the screen was the evidence they conveyed that the Americans were not only able to produce things on an enormous scale of magnitude, but were also alive to the beautiful, and had made rapid strides in artistic matters. If he might speak for the British exhibitors, he should say that they felt it not only a pride and a pleasure, but a duty to accept the kind invitation from America to take part in this great Exhibition. He hoped that English manufacturers would rise to the occasion, and take their true position. Hitherto we had maintained our industrial supremacy, but that was now being assailed, and it was now becoming a sort of warfare, not one involving such lamentable results as accompanied warfare in olden times, but a peaceful contest, in which, as had been said, there were victories to be gained. He hoped England would not only gain material advantages from this Exhibition, but that there would be great moral advantages in uniting the two nations. They only wanted to know one another. Charles Lamb said he always hated people he had never seen, but he never thoroughly disliked a man he had once spoken to. The more we came in contact with our cousins on the other side of the water, the more we should appreciate each other, for it was isolation which bred antagonism.

Mr. JOHN O'CONNOR said he could not claim to be a large manufacturer of anything, nor yet to represent an island which was famous for its manufactures, unfortunately. He would not go into the causes why Ireland had not large manufactures, but he was glad to know that the manufactures she possessed would be well represented. Thanks to a great English lady, she would be also represented at the World's Fair. Lady Aberdeen had found her way not only to the homes of the Irish, but to their hearts also; ever since she came amongst them in 1886, she had devoted her great natural gifts and abilities to arousing an interest in the people who had hitherto forgotten and neglected them, and in the arts that still lingered in the cottages of the poor people of Ireland. When the Royal Commission was created, and when the various countries of the world were summoned to send specimens of their skill to the World's Fair, Lady Aberdeen again came forward, and he could promise those who went to Chicago next year that, if they paid a visit to the Irish Cottage, and looked up the linens of the north and the woollens of the south of Ireland, they would not be disappointed; and he hoped it would be found that Ireland was not the least part of the British Empire. They were proud to take a part in the Exhibition; they were emerging from a period of darkness; the light was dawning over Irish manufactures and industry; a new spirit had been aroused, which, he hoped, would be extended, until the people would have something more than the one industry of agriculture to depend upon. He had been honoured by a place on the Royal Commission, and it had been his privilege in another place to assist the chairman of the Council in obtaining the increased funds which had enabled it to carry on its work with success, and to relieve exhibitors from the burden of paying for space, and also to assist the Ladies' Committee in making what he helped would be a worthy display. There were gentlemen present who thought the ladies demanded more money than the committee could afford to give them; but whenever that economical feeling prevailed, the ladies always sent a deputation, and the opposition very soon faded away. In this connection, he would say that, whatever measure of success attended the British Section of the World's Fair, it would be due, to a great extent, to the labours and patriotism of the Ladies' Committee. He had felt it a great privilege to be allowed to co-operate in furthering this noble project, which, notwithstanding the 50 miles' walk which Mr. Dredge told them they would have to take to view the exhibition properly, many of them intended to visit, and he was sure it would do much to cement together the people of the civilised world, and to advance one of the objects of the Society, which was to help forward the industries which affected the poor.

Sir JOHN PULESTON, M.P., congratulated Mr. Dredge on the very interesting paper he had given, for though they had all heard and read a great deal about the Chicago Exhibition, it required the facts and figures to be formulated and brought together, as he had done, to realise fully the extent of this great enterprise and what was expected to come of it. The keynote of the evening's proceedings had been the promotion of international friendship and commerce; and he felt sure that, whatever else might result, both these objects would be largely accomplished, not only to the benefit of England and America—who should only rival each other in the means of doing good to the world — but by cementing and bringing into equally friendly rivalry all other nations who took part in the enterprise. It was a very happy thought on the part of the Government of the day to commit the management of the British Section to the Council of the Society of Arts, and he was sure he only echoed the feeling of every one there in expressing the hope that the Chairman of the evening would be able to take as active a

part in this Exhibition as he had in many which had gone before.

Mr. ACWORTH said he desired to say a word on behalf of those, and he feared they were many, who would not be able to go to Chicago. How were they to know, each in his own particular line, the results of the Exhibition? The subject in which he was interested was transportation, and he was glad to hear that in that respect there would be the finest exhibit the world had ever seen, but he did not much expect to be able to go, and he hoped the Council would take means to secure the best and most instructive report possible for the use of those at home. He believed an immense deal might be learned in this matter from American experience, but exhibits required to be properly described by those who understood the subject, and who understood, also, the points in which English and American conditions varied, and what adaptations were necessary to make the American improvements suitable for use in England. Anything which would make transport in England cheaper, whilst maintaining its efficiency, in which he held we stood second to none, would be of as much service as anything likely to come from the Exhibition.

Mr. R. H. TWEDDELL said that what he had seen and heard that evening had somewhat weakened, in his mind, the force of the proverb which they all learned at school, that Rome was not built in a day. It seemed to him that this Exhibition had been built in a very few days, and he did not know what the Americans would not be capable of in a short time. He had had some experience of exhibitions during the last twenty years, and owed a great deal to them, but he thought he had now got all out of them that he wanted; in fact, his opinion was that for a beginner there was no place like an exhibition, but for an older man who had got through the battle they were a nuisance. At the same time he wished every success to this one, and if English interests were as well looked after as they were in Paris in 1876 by the Chairman, there could be no cause of complaint. As Mr. Dredge had said, exhibitions were not merely matters of sentiment, they resolved themselves into a question of £ s. d. with most people. Some persons were supposed to exhibit for art's sake, but it seemed to him that the old high ground which art used to occupy was getting slightly shaky. When there was just the same sort of competition with regard to it as in the manufacture and sale of tin-plates, no one could blame the Americans for looking after them. Englishmen might hold their own at home, and they could respect Americans all the more for looking after their own interests; but he had always found that if an Englishman made a machine which worked better than an American one, there was not a keener buyer of that competitive engine than the American engineer.

Professor ROBERTS-AUSTEN, F.R.S., said he had only spent a few hours in Chicago, but one thing he saw there struck him very much. The proprietors of a large warehouse had evidently been annoyed at an assembly of people about their place, and they had stuck up a large placard saying that one more loafer was required to sit on the rail. But they had seen that evening such remarkable evidences of industry, that he thought the race of loafers must be extinct. The portion of the exhibition with which he was least satisfied, was that which related to his own branch of science—mining and metallurgy; and seeing the enormous amount of iron and steel used in the buildings, and therefore the importance of Great Britain being well represented in that department, he did hope that all who had influence with those interested in those industries, on which our material prosperity so largely depended, would implore them to send their goods to the Exhibition.

The CHAIRMAN said he had now to express on behalf of the audience their gratitude to Mr. Dredge for his interesting paper, and also on the part of the great American nation, for no one in this country had taken such a warm and deep interest in their effort to make the World's Fair what it was going to be—a great success—as Mr. Dredge. All his colleagues on the Commission were much indebted to him for enlightening them on a number of most important points in connection with the Exhibition, and not only they, but the British exhibitors also, owed him a deep debt of gratitude. They were glad to know that he was appreciated in America, and that the great part he had taken in putting the case before the British public was thoroughly recognised. This was the third paper he had given in that room on the subject, and they could all look forward with pleasure to hearing another from him next year, when they would be able to award the crown of victory to those who had been successful in maintaining the position of the British Empire in the face of the world. He begged to propose a most hearty vote of thanks to Mr. Dredge.

The vote having been carried unanimously,

Mr. DREDGE, in response, said there was really nothing for him to reply to, as the discussion had shown no difference of opinion. All the speakers had displayed unanimity in expressing sympathy with the Exhibition, and hopes for its success, in condemnation of the McKinley Tariff, and also in an exaggerated estimate of the merits of the paper, for which he thanked them heartily. With reference to Mr. Acworth's remarks, he need only say that, after the way in which the Council of the Society had dealt with previous exhibitions in which they had been less interested, and had incurred far less responsibility, there was no reason to fear that it would not in due time place before its members the fullest and most detailed reports of the important features of the Exhibition at Chicago.

Miscellaneous.

TREATMENT OF SILVER ORES IN BOLIVIA.

In Bolivia, the following system of treating silver is practised:—The ore is first passed through a crusher, and then separated by hand, Indian women being employed for the purpose, for which they are paid from 30 to 35 Bolivian cents per day. The United States Minister at La Paz says that ores, having 50 and more marcs per cajon, or say 165 ounces troy per ton and above, are placed in 100 lb. sacks and shipped to Europe, while the lower grade metal, down to 20 marcs per cajon, or yielding say 65 ounces of silver per ton, are treated at the mines, while all ores carrying less than 65 ounces are generally rejected as worthless. The first process here employed consists in milling the ore. The mills used for this purpose are of three kinds, each made of stone, and are of the most primitive character, and the following is a description of them:—First, is the *quimbalete*, which is simply a large boulder, with a short pole lashed to the top with raw hide, to serve as a lever in rocking it backwards and forwards through the segment of a circle of about five feet in diameter over a flat stone, upon which the metal is thrown, so as to be caught under the rocking boulder. This mill, which is generally used where hot water is scarce, is operated by a single Indian; or, if it be a "double-handed quimbalete," that is, if the pole is lashed midway across the top of the boulder, then two Indians are required, who, sitting astride either end of the pole, work it up and down. The second is the *trapiche*, and is the primitive form of the present Chilian mill. It consists of a large stone wheel, six feet in diameter and five feet wide, called *voladora*, whose axle is connected with a perpendicular shaft, on which rests, horizontally, a large wooden wheel, which, being propelled by water, drives the *voladora* around on a flat circular stone, called *solera*, upon which the metal to be thus milled is thrown from time to time. In milling gold ores, the water serves the double purpose of driving the mill and washing the metal. Rushing down a sluice-box, called *chiflon*, at an angle of 45°, and striking the buckets, which consist simply of upright pieces of board, extending across the top of the wheel from its rim towards its centre, it falls upon the ore traversed by the *voladora*, carrying off the fine particles into a pebble-paved sluice-box, about 6 feet long, where the metal and quicksilver are finally deposited. The capacity of a new mill of this kind is about two tons per day of twenty-four hours, but as it wears rapidly, its capacity is proportionally lessened, until, at the end of twelve or eighteen months, a new *voladora* is required. The third is the *arrastra*, and consists simply in substituting a large boulder for the stone wheel of the *trapiche*, which, being lashed to the end of the axle, is dragged over the metal, thus milling it by friction. Thousands of these *arrastras volantes*, and *voladoras* are scattered about the abandoned works of Araca, the silent witnesses to the vast mining operations of the early Spaniards at that point. The ore being thus milled, is next subjected to the ordinary processes of amalgamation and washing, and the metal is then taken up by quicksilver and placed in cast-iron receptacles and pressed, thereby giving it form and expelling a large per-centage of quicksilver, when it is removed from the press and placed in a retort, where the remaining quicksilver is removed, leaving as the finished product a porous mass of pure silver in the shape of a pine-apple — hence its Spanish name, *plata pina*, or silver pineapple. This is the class of silver used for coining and in the industrial arts. This process of treatment was first introduced by the early Spaniards, and was a great advance over the smelting process they found in use among the ancient Indian miners, which consisted simply of small cone-shaped furnaces, called in the Aymara language, *gnayra*, meaning blasts, built upon the tops of the hills and mountains, where the strong winds rushing through the air funnels in the sides of the furnace fanned the charcoal fires within, until the metal was separated from extraneous substances.

Correspondence.

CREMATION AS AN INCENTIVE TO CRIME.

To have been able to make a proper reply to Mr. J. C. Swinburne-Hanham last Wednesday, I ought I think, to have been allowed to see what he is supposed to have said in the connected form in which it appears in the *Journal*, for I did not gather from what he did say anything like the account printed.

1. Mr. Hanham, I see, in the first place, reassumes the favourite fallacy of the cremationists that there is only one way of burial.

2. I did not say that exhumation was a "certain" way of detecting crime. What I said was that it was better than the "no way" allowed by cremation.

3. Mr. Hanham's statement that only three poisons can, with anything like certainty, be detected by exhumation is not only not true, but shows how dangerous such unwarrantable statements are when made by persons uninformed on such technica matters. Preparations of lead, zinc, copper, all the mineral acids, and most of the vegetable, such as oxalic and prussic; cyanide of potassium, all the caustic alkalis, verdigris, &c.; carbolic acid again (a common poison); chlorine, and nearly all its poisons; opium and all its salts; in a word, most, if not all, poisons in common use (except the vegetable alkaloids) are detectable by exhumation, to say nothing of all traumatic lesions.

4. That "only five exhumations are made per annum" is without any foundation whatever, and, like Sir H. Thompson's statement to the like effect, utterly misleading.

5. The mention of the "viscera removed and preserved by the Cremation Society in a sealed jar," is interesting, but at the same time reveals, in an unmistakable way, how little the duties and responsibilities of a medical expert are understood by Mr. Hanham, and the society he represents. When poisoning has been accomplished by a large dose or two, you may, indeed, expect to find it in the viscera, except when, as is frequently the case, it has been removed by vomiting and purging; but when, as an accomplished poisoner would do it, it has been effected by small doses frequently repeated, it is not in any part of the *primæ viæ* that you would look for it, but in the remote effluent organs, like the liver and kidneys, or in the blood, or even in the *excreta*—both fluid and solid—themselves. Death, in fact, may have been undoubtedly caused by a poison, and yet not a particle of that poison be found, even in the tissues, far less in the stomach and bowels.

The above are sufficient to expose the profound ignorance which characterises cremationist statements in general, but which are not the less calculated to impose on the public.

F. SEYMOUR HADEN.

Woodcote Manor,
Nov. 26, 1892.

Obituary.

W. MATTIEU WILLIAMS, F.C.S.—Mr. Mattieu Williams, who was well known to the members of the Society as a lecturer, died suddenly on Monday, 28th November, at his residence, near Willesden, in his 74th year. Mr. Williams spent his early days in London, and was apprenticed to an optical instrument maker when only 11 years of age. Inheriting a small sum of money, he removed to Edinburgh, and studied there for some time. During his stay he made the acquaintance of George Combe, with whose views on education he was in sympathy, and a result of their friendship was the foundation of the Williams Secular School, in which experimental science formed an important part of the curriculum. At the foundation of the Birmingham and Midland Institute, in 1854, Mr. Williams was appointed master of the classes then forming the industrial department. About 1862, Mr. Williams left Birmingham, and for a time was employed in business pursuits. He was a voluminous writer, and the best known of his works are "The Fuel of the Sun," and "Through Norway with a Knapsack." Mr. Williams delivered several courses of Cantor Lectures before the Society of Arts. In 1876 he lectured on iron and steel manufacture, in 1878 on mathematical instruments, and in 1882 on the scientific basis of cookery. On March 19th, 1879, he read a paper before the Society on "Economic gardens in the midst of London and other smoky towns."

General Notes.

CHEMICAL SOCIETY.—This Society will commemorate the anniversary of the death of the great chemist, Jean Servais Stas, by holding a meeting on Tuesday, 13th inst., when will be read a paper by Mr. J. W. Mallet, F.R.S., entitled "Jean Servais Stas and the Measurement of the Masses of the Atoms of the Chemical Elements."

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

DECEMBER 14.—"The Utilisation of Niagara." By PROF. GEORGE FORBES, F.R.S. SIR RICHARD WEBSTER, Q.C., M.P., will preside.

Papers for meetings after Christmas :—

"Transatlantic Steamships." By PROF. FRANCIS ELGAR, LL.D.

"The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air." By PROF. FRANK CLOWES, D.Sc.

"The Purification of the Air Supply to Public Buildings and Dwellings." By WILLIAM KEY.

"Pottery Glazes: their Classification and Decorative Value in Ceramic Design." By WILTON P. RIX.

"On some Points in the Chemical Technology of Oil Boiling, with an account of a New Process for Preparing Drying Oils, for Decorators' and Artists' use." By PROF. W. NOEL HARTLEY, F.R.S.

"The Mining Industries of South Africa." By BENNETT H. BROUGH.

"Ten Years of Progress in India." By SIR WILLIAM WILSON HUNTER, K.C.S.I., C.I.E., LL.D.

"Australasia as a Field for Anglo-Indian Colonisation." By SIR EDWARD N. C. BRADDON, K.C.M.G., Agent-General for Tasmania.

"Indian Manufactures." By SIR JULAND DANVERS, K.C.S.I., late Public Works Secretary, India-office.

"Caste and Occupation at the last Census of India." By JERVOISE ATHELSTANE BAINES, I.C.S., Imperial Census Commissioner for India.

"Mexico, Past and Present." By EDWARD J. HOWELL.

"Newfoundland." By CECIL FANE.

"New Zealand." By W. B. PERCIVAL, Agent-General for New Zealand.

"Upper Burma under British Rule." By H. THIRKELL WHITE, C.I.E.

"The Currency Problem." By J. BARR ROBERTSON.

"Agrarian Legislation for the Deccan, and its Results." By SIR RAYMOND WEST, K.C.I.E.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday Afternoons, at Half-past Four o'clock:—

January 19; February 16; March 9; April 6, 27; May 11.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four or Eight o'clock:—

January 17; February 28; March 21; April 2, 16.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 24; February 7, 21; March 14; April 11; May 9.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock:—

PROF. VIVIAN LEWES, "The Generation of Light from Coal Gas." Four Lectures.

LECTURE IV.—DECEMBER 12.—The effect of the constituents of the atmosphere on the light emitted by flames—The probable limit of light to be obtained from gas—The measurement of light.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday Evenings, at Eight o'clock:—

PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

January 13, 20, 27; February 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DEC. 12... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "The Generation of Light from Coal Gas." (Lecture IV.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Mr. R. Hedger Wallace, "Some Problems in Agricultural Teaching at Home and Abroad." 2. Mr. Charles A. Stevenson, "Note upon Mode of Calculating Spherical Refractor."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Major Lamorock Flower, "Water Supply—Pollution of Water—Drinking Water."

TUESDAY, DEC. 13...Chemical Society, Burlington-house, W., 8 p.m. Extra Meeting on the Anniversary of the Death of Stas. Prof. J. W. Mallet, "Jean Servais Stas, and the Measurement of the Relative Masses of the Atoms of the Chemical Elements."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. John Rigby's Paper, "The Manufacture of Small Arms." 2. Mr. J. Emerson Dowson, "Gas-Power for Electric Lighting."

Asiatic, 22, Albemarle-street, W., 4 p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Major Darwin, "Lens Testing at Kew."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. A. J. Evans, "A Pre-historic Interment in the Cave of Barma Grande, near Mentone." 2. Mr. H. Colley March, "Polynesian Mythography—a Symbolism of Origin and Descent." 3. Professor Politis, "Burial Customs in Modern Greece."

Colonial Inst., Whitehall Rooms, Northumberland-place, S.W., 8 p.m. Mr. Everard F. Im Thurn "Notes on British Guiana."

WEDNESDAY, DEC. 14... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. George Forbes, "The Utilisation of Niagara."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7 p.m. 1. Discussion on Mr. J. R. Fothergill's Paper, "The Combustion of Coal and Prevention of Smoke." 2. Discussion on Mr. J. Denholm Young's Paper, "A System of Mechanical Aid to the Investigation of Speed Curves." 3. Mr. D. B. Morison, "Marine Boiler Furnaces."

Patent Agents, 64, Chancery-lane, W.C., 7½ p.m. 1. Discussion on Mr. de Pass's Paper, "Section 44 of the Patents, Designs, and Trade Marks Act, 1883." 2. Mr. G. B. Ellis, "Lapsed Patents."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, DEC. 15...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. Maxwell T. Masters, "Notes on the Genera of Taxacea and Coniferæ." 2. Mr. George Brook, "Note on the Affinities of the Genus Madrepora."

Chemical, Burlington-house, W., 8 p.m. 1. Messrs W. R. Dunstan and W. F. J. Shepheard, "The Identity of Caffeine and Theine." 2. Dr. Moody, "Studies on Isomeric Change, 1, 2, 3 Orthoxylene, Sulphonic Acid, Phenitolsulphonic Acid."

London Institution, Finsbury-circus, E.C., 6 p.m. Rev. Dr. Dallinger, "Ants: a Study of Socialogy and Politics amongst Insects."

North-East Coast Institute of Engineers and Shipbuilders (Graduate Sections), Newcastle-on-Tyne, 7½ p.m. Mr. J. Brentnall Duckitt, "Continuous Current Dynamos."

Historical, 20, Hanover-square, W., 8½ p.m.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

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FRIDAY, DECEMBER 16, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 4 and 11, by R. Bowdler Sharpe, LL.D., on "The Curiosities of Bird Life."

The lectures will commence at seven o'clock. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and an adult.

Tickets are now in course of distribution, and members requiring them should apply at once.

CANTOR LECTURES.

On Monday evening, 11th inst., Prof. Vivian Lewes delivered the fourth and last lecture of his course on the "Generation of Light from Coal Gas."

On the motion of the Chairman (Mr. Francis Cobb), a vote of thanks was passed to the lecturer for his interesting course of lectures.

The first lecture will be printed in the next number of the *Journal*.

PRIZES FOR DESIGNS FOR FURNITURE.

The Council of the Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Memorial Committee, on condition of their spending the interest thereof in prizes to "Students of the Schools of Art, who in annual competition produce the best designs for Household Furniture, Carpets, Wallpapers and Hangings, Damasks, Chintzes, &c., regulated by the principles laid down by Owen Jones."

The prizes will be awarded on the results of the Annual Competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in the competition.

The next award will be made in 1893, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones's "Principles of Design," and the Society's Bronze Medal.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 14th inst. Present: Sir Frederick Bramwell, Bart., D.C.L., F.R.S., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Braddon, K.C.M.G., Michael Carteighe, Sir George Hayter Chubb, Lord Alfred S. Churchill, Francis Cobb, Sir Phillip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Prof. James Dewar, M.A., F.R.S., James Dredge, F. Elgar, LL.D., Walter H. Harris, John B. Martin, Sir Owen Roberts, M.A., Prof. W. Chandler Roberts-Austen, C.B., F.R.S., with Sir Henry Trueman Wood, Secretary to the Royal Commission.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Monday, 11th December. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Alfred Carpmael, R. Brudenell Carter, F.R.C.S., Francis Cobb, Sir Philip Cunliffe - Owen, K.C.B., K.C.M.G., C.I.E., Sir Henry Doulton, James Dredge, John B. Martin, John O'Connor, W. H. Preece, F.R.S,. with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

AGRICULTURAL COMMITTEE.

A meeting of the Agriculture and Food Products Committee was held on Thursday, 8th inst., at the house of the Royal Agricultural Society, 12, Hanover-square. Present: Earl of Feversham in the chair; H.R.H. Prince Christian, K.G., G. Mander Allender, Alfred Ashworth, R. Bannister, Dr. Ball, F.R.S., Earl Cathcart, Sir Nigel Kingscote, Hon. Cecil T. Parker, John Thornton, C. W. Wilson, Sir Henry Trueman Wood, Secretary to the Royal Commission, and Ernest Clarke, honorary Secretary of the Committee.

FINE ARTS COMMITTEE.

A meeting of the Fine Arts Committee was held on Thursday, 8th inst. Present: Sir Frederick Leighton, Bart., P.R.A., in the chair; H. W. B. Davis, R.A., Sir James D. Linton, P.R.I., W. E. Lockhart, W. W. Ouless, R.A., Sir Henry Trueman Wood, Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

Proceedings of the Society.

FIFTH ORDINARY MEETING.

Wednesday, Dec. 14th, 1892; Sir RICHARD WEBSTER, Q.C., M.P., Chairman of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Anderson, Tom Scott, 59, Wilkinson - street, Sheffield.
Ferrar, William Grey, Broad-street House, E.C., and Redclyffe, Ilford, Essex.
Giddy, Osman F., 121, Pall-mall, S.W., and Cambernauld, Feltham-hill.
Heap, Ray Douglas Theodore, 35, Addison-gardens, Kensington, W.
Statham, William, The Redings, Totteridge, N.

The following candidates were balloted for and duly elected members of the Society:—

Evens, Richard Underhay, 43, Baker-street, W.
FitzGerald, Colonel Charles John Oswald, C.B., Dunmore, Eastbourne.
Foster, Frank, Adelphi-chambers, 7, John-street, W.C.
Gaikwad, Shrimant Sampatrao K., National Liberal Club, S.W.
Joy, David, 17, Victoria-street, S.W., and Manor-road-house, Beckenham.
Roechling, Herman Alfred, 23, Highfield-street, Leicester.
Snowden, Frederick, Aberglaslyn, Amherst-park, Stamford-hill, N.
Voelcker, J. Augustus, Ph.D., 20, Upper Phillimore-gardens, W.

The paper read was—

THE UTILISATION OF NIAGARA.

By PROF. GEORGE FORBES, F.R.S.

When I was asked to read a paper on the work which had been undertaken with the object of utilising the Falls of Niagara, I at first thought that the time had hardly yet arrived for doing that. It is true that the hydraulic part of the enterprise has been pretty fully developed, and that the engineering works on the spot have been pretty well completed, and that the turbines have been designed and put out to contract; but the electrical part of the scheme, for which alone I am in any way responsible, has not yet been made public, and I thought it would be best to delay speaking on the subject until the contracts had been given out. On thinking the matter over, however, I saw that there was ample material to spend an hour profitably in showing you generally the character of the work which had to be undertaken, the objects to be fulfilled, and the extent to which these plans have been completed up to the present moment.

I have a number of lantern slides which will serve to show you the general character of this enterprise, some of which have been prepared to illustrate the different views of the Falls, while the others are devoted to details of the engineering works taken from photographs made during their construction. A few of these are from my own negatives. The photographs will serve to show, first, the conditions of the problem, and, second, the manner in which it has been attacked.

The situation of Niagara Falls is peculiarly favourable, both from the engineering and commercial point of view. As a source of water power, it stands almost unrivalled, not only on account of the enormous volume of water, and the considerable height of its fall, but also on account of the unvarying volume which is continually flowing. From a commercial point of view the situation of the Falls is perhaps unique, and the originators of this

enterprise can find much to support their views—that they are entitled to look forward to the prospect of founding, in the immediate vicinity of the Falls, a manufacturing town greater than any which exists in the United States. This sounds a somewhat too enthusiastic view of the matter to those who are accustomed only to a comparatively slow rate of progress in European affairs. But when one sees a town like Minneapolis springing up to its present proportions in the course of a few decades, due to the development of some fifteen thousand horse power, used by the water-wheels there, and the industries which have sprung up to utilise the water-power developed at Holyoke, Mass., one can imagine the effect that the utilisation of Niagara Falls will have on the prosperity of the locality. The great developments of electrical industry, either from a manufacturing, mining, or agricultural point of view, are in the far West; and the enormous group of navigable lakes form a natural highway for the transport of raw products, most of which require the expenditure of power to convert them into articles of commerce. Niagara Falls being situated at the eastern extremity of these lakes, which is the end nearest to the consumers, they evidently occupy an advantageous position. Three principal lines of railway pass in the immediate vicinity of the land owned by the company which is developing the power of Niagara Falls, and a terminal railway has already been built by them to connect the different parts of their property with these three lines of railway. The Erie Canal also passes from this point to the Hudson River and thence to New York, and Niagara Falls being actually on the frontier of Canada open up the whole of that country to commerce. Thus we see that both from an engineering and commercial point of view this situation is peculiarly favourable to a rapid development.

The reason why the flow of water at Niagara Falls is extremely regular, is that we have such an enormous reservoir upon which to draw for our supply, this reservoir consisting of Lakes Superior, with an area of 33,517 square miles, Michigan with an area of 24,200 square miles, Huron with an area of 28,193 square miles, and Erie with an area of 11,574 square miles, being in all about 90,000 square miles of reservoir surface, draining a watershed area of 241,235 square miles. The volume of water which is continually flowing has been variously estimated. The late Sir William Siemens considered that the flow of water over the Falls was sufficient to develop 16,000,000 of horse-power, but probably the result is considerably less. The Lake Survey Board has put the flow of water at 265,000 cubic feet a second. Mr. R. C. Reid, in a paper read before the Royal Scottish Society of Arts on the 23rd of March, 1885, has made an independent estimate closely agreeing with this. He says:—

"The drainage area of the whole Lake Basin down to Niagara is 290,000 square miles, and of that there is of lake surface 92,000. The average rainfall in the lake district may be taken at 36 inches, and taking the average loss by evaporation and absorption at the figures given for the Mississippi Basin, namely, 20 inches, there will be sixteen inches of rainfall that finds its way into the lakes. Again, on the surface of still water the evaporation is 24 inches per annum, which would leave 12 inches of rainfall collected on the surface of the lakes. A rainfall of 16 inches is very nearly equal to an average flow of $1\frac{1}{6}$ foot per second per square mile, while 12 inches would equal $\frac{7}{8}$ of a foot per second per mile. The average flow will therefore be—from the land, 198,000 square miles $\times$ $1\frac{1}{6}$ foot per second per mile, giving 231,000 feet per second: and from the 92,000 square miles at $\frac{7}{8}$ of a foot per second per mile, 80,500 feet per second. This gives a total of 311,500 cubic feet per second."

As an example of the effectiveness of these lakes as a reservoir, Mr Reid says:—

"If a rainfall of 3 inches in the 24 hours were to fall simultaneously over the vast region draining into Lake Superior, it would only have the effect of raising the lake 9 inches. In that case, it would take 90 days to run off into Lake Huron, which, with Lake Michigan, would take as long to run off into Lake Erie; so that it would take six months for the full effects of a flood in Lake Superior to be spent at Niagara Falls. The total fall in the river from Lake Erie to Lake Ontario is 329 feet, divided as follows:—Lake Erie to the rapids above the Falls, 15 feet; in the rapids, 55 feet; at the Falls, 161 feet; and from the Falls to Lake Ontario, 98 feet. The total power in the Falls, from the head of the upper rapids to the whirlpool rapids, according to the above estimate as to volume of water, is 9,400,000 horse-power, or about 7,000,000 horse-power, after allowing for loss of efficiency in the turbines. This is with a fall of 276 feet."

The actual fall which will be used by the Cataract Construction Company is only half of this, or 140 feet, and consequently the power which they would be capable of developing, if they utilised the whole of the Falls, would be about 3,500,000 horse-power effective.

There are two falls at Niagara shown by the lantern—one called the Horseshoe Fall

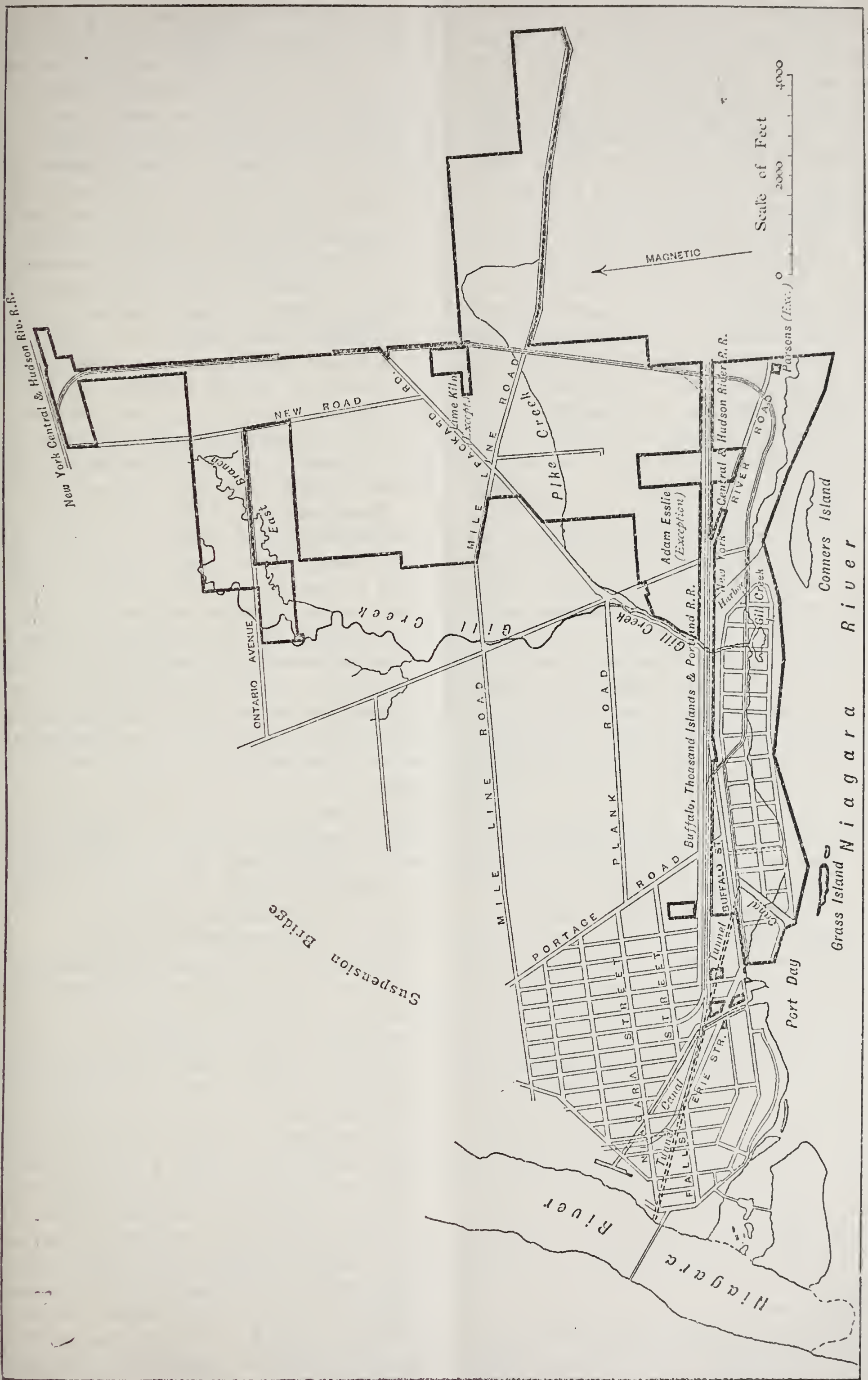
and the other the American Fall. The former has a length of 812 yards, and the latter of 325 yards, but about $\frac{9}{10}$th of the water passes over the Horseshoe Falls, and only about $\frac{1}{10}$th over the American Falls. It might be supposed, then, that when 100 or 200 horse-power are taken from the American side of the river for conversion into power, there would be a material diminution in the volume passing over the American Falls; but from a special investigation made by Mr. Bogart, it appears pretty certain that the deficiency of water will be made up by the water from the other side of the river, before the latter has been divided between the two falls by Goat Island.

The idea of utilising the Falls of Niagara is a very old one, but it is only of late years that the application of electricity has been sufficiently developed to make the problem of distributing the power capable of being worked out on a paying financial basis. The power of the Falls has, however, been utilised to a certain limited extent for many years past. A canal has been cut from the river above the falls on the American side, skirting the side of Niagara Falls city, and ending at the clifts about half a mile below the American Falls. At this point a few acres of land are given up to mills, where turbines are placed, and the water is discharged from the face of the cliff after having utilised only a very small proportion of the fall available. When the Cataract Construction Company undertook to further develop the wasted power, an extension of this plan of using a canal was open to many objections. There was a difficulty in getting rights of way, and there was also a difficulty in getting a suitable tract of land on the face of the cliffs for developing a manufacturing city. Moreover, by having the manufacturing city which is to be developed a mile or two above the Falls, it would not interfere in the same way with the natural beauties of the place. It was consequently resolved to develop the new method which has now been carried out. About a mile and a half above the American Fall a canal has been dug out 500 feet wide, and 1,500 feet long, with a depth of 12 feet. Along the edge of this canal, wheel pits are being dug 160 feet deep, at the bottom of which turbines will be placed. The water is admitted to the penstocks by lateral passages or head-races which can be closed by gates. After the water has exerted its power upon the turbines, it flows into a tunnel, with a grade of 7 feet per 1,000, which carries it away a distance of 6,700 feet, under the city of Niagara Falls, and the water is discharged in the chasm below the Falls, just below the suspension bridge. I have a number of lantern slides showing the progress of these works in various stages.

The most important piece of work was the cutting of the tunnel. The rocks through which this passes consist of limestone and shale. It was hoped, at first, that, by driving the tunnel altogether through the limestone, no lining would be necessary. Specimens of the limestone were forwarded to experts, and from the reports of these gentlemen, there seemed little doubt that these expectations would be realised. But at the very commencement of the work it became apparent that the character of the rock was such that exposure to the air deteriorated it, and it was not possible to proceed without lining the tunnel. This involved considerable extra expense, but it enabled us to bring out the mouth of the tunnel at a lower level—that is to say, in the shale. The extra cost of lining this tunnel with four courses of bricks was very considerable, but it is to be hoped that by so doing, a permanent structure has been provided which will not give trouble in the future. At the mouth of the tunnel, a lining is provided on the invert and sides made of cast-iron plates. The rock excavation had an average height of 26 feet, and was effected on three different benches. The top bench, 9 feet high, to the top arch has always extended ahead of the second bench, 8 feet high. When these were completed, the bottom bench was commenced. The tunnel is shaped something like a horseshoe. It may be taken as being about 19 feet wide by 21 feet high inside the brickwork, and has a cross sectional area of 386 square feet over its entire length. Three shafts were used in construction, one on the face of the cliff at the mouth of the tunnel; another called Shaft No. 1, 2,650 feet from the mouth, with a depth of 206 feet, and a section 10 feet by 20; while shaft No. 2, at 5,200 feet from the mouth, is the same size, and is 196 feet deep.

The rough arch cut in the rock was lined with timber. Then four courses of brick were built inside to form the arch, and the space between the timber and brick was filled at the top with rubble, and at the lower parts of the arch with rubble and cement.

The engineering work of importance, next to the development, was the cutting of the canal, whose position is shown on the large map. It was found necessary to line this canal with solid masonry. Apertures are left, at definite



Walker & Boutall sc.

Lands of the Cataract Construction Company.

points, to admit water for the head-races into the penstocks for the turbines. In order to dig out this canal it was necessary to make a cofferdam at its outlet, to prevent the works from being flooded by the river. This cofferdam forms only a part of a system of cofferdams, which already extend along a considerable distance on the face of the river. These cofferdams form the boundary of a large tract of land which has been reclaimed from the river. The material used in their construction, and in filling up the reclaimed space, was made of the material taken out of the tunnel. In this manner 30 acres of reclaimed land have been reserved for the Niagara Falls Paper Company, who have already constructed enormous factories for the manufacture of paper from wood pulp. This company utilises the water-power direct, and leases from the Cataract Construction Company the right to use the tunnel as a tail-race. It has sunk its own wheel pit, and is putting in its own turbines, to the extent of 6,000 horse-power. The Cataract Construction Company has already sunk a shaft sufficient to accommodate three of the 5,000 horse-power turbines which are to be used for the work of distributing light and power. Considerable difficulty was met with in sinking this shaft, by the influx of water through a seam at a depth of about 30 feet below the surface. These difficulties have never interfered with the progress of the work, which has now been successfully carried out. The turbines which are to be used are of 5,000 horse-power, revolving at 250 revolutions per minute, of the Girard or impulse type, with a regulator for adjusting the flow of water. Each turbine is double. Attached to the shafts of the turbines are vertical shafts, extending to the surface of the ground, and, on the top of these shafts, the dynamos are to be mounted, which will transmit electricity, for light and power purposes, to the surrounding districts and to Buffalo. The turbines are from the designs of Messrs. Faesch and Piccard, of Geneva, who transmitted the working drawings to America; and the contract for these turbines has now been given out to the I. P. Morris Company, of Philadelphia, two turbines having been ordered in the first instance. Twenty of these will be required to utilise the full capacity of the tunnel, which is 100,000 horse-power.

Having now given some account of the hydraulic part of the work, and of the engineering construction, it will be well to say something about the manner in which this power is to be distributed and utilised. The directors of the company were very anxious that the best advice possible should be obtained on this point, and, in 1890, they appointed a Commission, which sat in London, under the presidency of Lord Kelvin, assisted by Professor Mascart, of Paris, Colonel Turrettini, of Geneva, and Professor Coleman Sellers, of Philadelphia, to consider the various proposals which had been made by several engineers and manufacturing firms who had been specially invited to submit projects for the utilisation and distribution of the power developed at Niagara Falls. Professor Unwin, who is now considering the problem of dealing with the hydraulic engineering for utilising the Horseshoe Fall, on the Canadian side, was the secretary. Among the projects submitted, the two most promising means of distribution were compressed air and electricity, but the further inquiries which have proceeded since the Commission was closed have resulted in the decision to adopt electricity. At one time it was thought that a large number of mills would be worked on the same plan as the paper company spoken of above—that is to say, by driving the mills directly by turbines in separate wheel pits having access to the great tunnel—but the expense of digging separate wheel pits for every mill is serious, besides that this plan would involve a considerable extension of the tunnel; and it has been considered best, not only for transmission to a distance, but also for most of the local distribution, to employ electricity for supplying the power to the different mills and workshops. The question of using compressed air was seriously considered, but it also gave way in convenience and economy to electricity.

Now, when I come to speak of the electrical part of the scheme I feel some diffidence, because we are at the present moment on the eve of settling the type of machinery to be used. I have before me for consideration more than twenty distinct plans of the 5,000 horse-power generators which may be used. Some of these are for continuous currents, others for alternating currents, and while I naturally have definite views as to which of the plans proposed is the most practical, I confess that, even at this time, I have an open mind which would be free to accept anything which seems more valuable than the best design we have received as yet. Of one point I may assure you most definitely, and that is that there is not the slightest difficulty in making this work successful from an engineering as well as from a

commercial point of view. My difficulties have consisted chiefly in the number of different ways by means of which it was possible to attain the results required. The types of machine which have been proposed vary in many essential features, and in none more than in the important item of the weight of the revolving part, which varies in these designs from 7 or 8 tons up to 60 tons; but it is quite remarkable that in a science of comparatively recent growth, as in the distribution of power electrically, there should be so few differences of opinion as to the means to be adopted, and the character of the machinery to be used. This is the more remarkable when I contrast it with any ordinary engineering machinery which is the growth of a hundred years or more. Even in the matter of such a common-place article as a steam boiler, the differences of view which exist among mechanical engineers is quite surprising, for it would have been supposed that, after so long a period of practical experience, the views of all engineers would have been brought into harmony by this time. The question of broad and narrow gauge has equally disturbed the equanimity of engineers, and in every department of steam engineering we find the widest differences of views existing among engineers. It is consequently a little surprising that electricians are so nearly agreed as to the methods and machinery to be used. There are two great classes into which this problem may be divided, depending upon the use either of continuous or alternating currents. Both of these are thoroughly available for the purposes under consideration, and each has some special advantages. A few years ago there was a certain dread of the use of alternating currents among a certain class, but this has gradually disappeared. Heated arguments were formerly used on both sides, but at the present day it is possible for all independent engineers to discuss these matters on a basis of pure reason, and no serious differences arise when the relative advantages of the two kinds of current are discussed among capable engineers. The continuous current has the advantage that the dynamos of this kind have been made in larger quantities, and that we can at a moment's notice procure on the market a motor of any moderate size. They can also be coupled in series or in parallel with the utmost facility. The alternating current dynamo has the advantages that it employs no commutator—a source both of expense and of risk in a continuous current machine, and also that the alternating current can be transformed up to a higher, or down to a lower pressure. A low pressure dynamo is a machine of more solid construction than a high pressure one. When the current has been created at low pressure, it can be converted by a transformer into high pressure, and so carried economically along fine wires to a distance where it can be reduced in pressure by a second transformer, and supplied to motors in a perfectly safe condition. With the continuous current, on the other hand, the motors must be of the same high pressure as that which is used upon the line, even if we adopt the combination of a motor and dynamo as a transformer for supplying low pressure current to workshops. Such an apparatus is far more objectionable than the alternating current transformer, which is at rest during the whole time of its action. It is also more expensive than the latter. When the distance to which the power has to be transmitted is short, it may become more economical to use low pressure and thick conductors instead of high pressure with transformers and thin conductors, but the distance to which this advantage extends is very short. The experiments which were made last year between Lauffen and Frankfort, show that we need not have the slightest fear about using so much as 20,000 volts in the transmission between Niagara and Buffalo, and if a subway be constructed over this distance in which to carry the conductors, we need not fear any climatic troubles, and inspection will be so easy that the conductors will always be in good order.

In 1890, I laid before the Commission my views as to the manner in which the desired results might best be obtained, and expressed myself at that time in favour of the use of alternating currents, most specially for the transmission to Buffalo, and I think that on this point there are no two opinions at the present time, although considerable opposition to this view was shown at the earlier date.

Alternating current motors may be divided into two classes, synchronising and non-synchronising motors. The former are mechanically identical with the alternating current generator, and revolve at constant speed governed by the speed of the generating machine. Of the latter class those best known are those depending for their action on principles discovered independently by Tesla and Ferraris. The former class have been in considerable use both in Europe and in America on what may be spoken of as a large scale, and they

are found to equal continuous current motors in efficiency. The latter class, especially those which are described as rotary phase motors, have been gradually developed since I related my experience with them to the Commission two years ago, and their efficiency, as guaranteed by the makers, now amounts to 90 or 92 per cent. Continuous current motors have been used to so great an extent, and more especially in electrical tramways, that it is unnecessary to enlarge upon their capabilities. There are many other kinds of motors which are available, but it would be tedious if I were to describe to you the action of all these different varieties. I will only mention one more system, which may be described as a combination of alternating and continuous currents, and which promises to do important work in the future. In the ordinary usage of a continuous current, the dynamo originally generates an alternating current, and the commutator is applied to the dynamo to convert it into a continuous current, and this procedure prevents us from taking advantage of that valuable adjunct, the transformer. Many engineers are now working at a plan whereby the commutator, instead of being put upon the dynamo, is put at the other end of the line after the high pressure alternating current has been reduced in pressure, and we are thus able to distribute a low pressure continuous current to the motors at the distant station, while we have been using a high pressure alternating current over the line. I will not say at present which of the numerous methods which are available to us are most likely to be adopted. I have said enough to show you that we have ample means at our disposal to establish a thoroughly successful plant from an engineering point of view. As to the commercial side of the question I must satisfy myself with stating to you in general terms that after having worked out the cost in every one of the different methods which have been proposed, I have no hesitation in assuring you that the cost at which a horse-power per annum can be sold either in the neighbourhood of Niagara Falls or at Buffalo, is such as to make the enterprise certain of success from a commercial point of view.

Hitherto I have sketched out the general engineering questions which have arisen, but beyond that there is a great deal as to the policy which has been adopted by the directors of this company. Those who have taken the most active part in its development are Mr. E. D. Adams, the president, Mr. L. Stetson, and Mr. E. A. Wickes, vice-presidents, and Mr. W. B. Rankine, secretary and treasurer. The consulting engineers include Professor Coleman Sellers, whose knowledge and experience of all classes of machinery is so well known, Mr. Bogart, who has had the construction of large engineering works under his charge, and Mr. Clemens Herschel, who has devoted his life to the development of hydraulic enterprises; while Col. Turrettini acts as foreign consulting engineer, my own position being that of electrical consulting engineer. Mr. Burbank is the resident consulting engineer, and Mr. Albert Porter the resident engineer.

The directors of the company have shown great foresight in a great deal of their work. The capacity of the present tunnel is sufficient to provide 100,000 horse-power applied to the turbines. Rights of way have been obtained for another tunnel of the same capacity on the American side. On the Canadian side a concession has been granted for utilising the Horseshoe Falls, and the extent to which these will be used may probably reach 250,000 horse-power. Thus we have in all 450,000 horse-power available.

Early in the history of this concern, before it had reached anything like a practical stage, about 1,500 acres of land had been bought up in the neighbourhood of Niagara Falls, and it is intended to develop this land as much as possible so as to make a great manufacturing centre. A great number of applications for power have already been received, and it becomes perfectly evident that the establishment of each separate industry will bring to the neighbourhood a large number of new industries. Thus we expect very shortly to have a copper refinery for electrolytic processes. This will naturally bring wire manufactories to the spot. Electric cables will also be made here, where the wire can be obtained cheapest. The wants of the company alone are sufficient to require the establishment of an electrical factory, and the facilities for transporting machinery by land or water will be such as to make it an important centre for the manufacture of large electric machinery, either for lighting, for traction, or other purposes. And so it appears likely to proceed, the success of one industry leading to the establishment of another, until the whole land of the company, and much more besides, is used up in the raising of what may eventually become the greatest manufacturing centre of the United States.

In order to give facilities of transport to those who establish themselves here, ample wharfage accommodation will be established, a matter which is comparatively easy since the company owns several miles of river frontage. With the same object in view a terminal railway has been built, and is now at work, connecting the principal streets belonging to the company with the three great lines of railroad which pass beside it. Contracts have already been given out for the construction of labourers' houses, and before long this part of the new city will have made sensible progress.

The company has also undertaken the water supply of the city, including the old part which was insufficiently supplied, aud they are also dealing with the matter of sewage.

Altogether, I may briefly state the impression which has been thrust upon me by an examition of the plans and works of the company, in saying that they have taken a most comprehensive view of the situation, and have proceeded up to the present with an amount of caution and foresight that cannot but augur well for the future of the enterprise.

I have often been asked whether the diversion of the waters of Niagara River will affect the picturesque character of the Falls. I do not think it will. The present tunnel will divert 100,000 horse-power. The company has rights for constructing a parallel tunnel of like capacity. The Canadian concession will allow of 250,000 horse-power being utilised. Thus we have a total of 450,000 horse-power which may be used, being about 12 per cent. of the total water. These are the utmost limits to which the company can divert the river, and in their American charters they have, unsolicited, limited their demands to 200,000 horse-power on that side of the river. I do not think that a difference of 12 per cent. in the flow of the water would be noticeable to the tourists who come to see the Falls. But I think it improbable that all this power will be utilised for a long time to come. If we put the value of a horse-power day and night at only £5 per annum, the above output represents an income of £2,450,000 per annum.

With regard to ruining the amenities of the place, we need not fear anything from the action of the company, but this has already been largely done by the Government of Ontario, to its lasting disgrace, for the sake of a paltry addition to their revenue. By the energy of Lord Dufferin, the Canadian banks of the river near the Falls were lately reserved for the people as a park, called Victoria-park. The Americans at the same time reserved the American shore and Goat Island for the people. Victoria-park was one of the loveliest spots on earth, where you could enjoy the scenery in quiet. This is all spoilt now. A concession has been granted for a railway, which has now been built with almost indecent haste. It goes along the edge of the cliff where formerly one could walk in peace and safety. It goes through the lovely Dufferin Islands, where massive iron bridges have been built for a double track of railway, and thus for the sake of a paltry annual income the Government of Ontario has mortgaged the benefits conferred on the world by Lord Dufferin.

In concluding this paper, I must express my admiration for the policy of forethought displayed by the directors of the company that is undertaking the harnessing of Niagara. They travelled all over the world to see what had been done already in transmitting power, and before settling on any plans they spared no expense to get the best advice through the Commission they appointed. The same forethought was shown in securing the rights of way for two tunnels on the American side and getting the control of the Canadian concession; also in buying up the land which is to be the site of the new city. As another example of this spirit, I may say that when I was appointed as their electrical consulting engineer, I was instructed to visit on their behalf and report to them on any works in any part of the world that seemed to me likely to be of use in giving us more information about the distribution of power by electricity. I am sure that you will all agree with me that a work of this magnitude and importance, commenced and carried out with so much practical wisdom, deserves to succeed, and I trust that many of you when on your way next year to visit the Chicago Exhibition will be able to stop at Niagara Falls, and see for yourselves the way in which these vast waste forces are being harnessed to the service of man.

DISCUSSION.

Professor W. C. Unwin, F.R.S., said he had had the opportunity, during last year, of crossing the Atlantic, to see the work which had been carried out at Niagara, and he must testify that he had never seen work more boldly undertaken, or more thoroughly executed. Nothing had surprised him so much as the extreme care which the promoters of this enterprise were taking to obtain information from every quarte

to accept and adopt every expedient, and to consider every proposal which came before them. The project for utilising part of the water-power of Niagara, on a larger scale than was done by the small mills on the cliff, was not a very modern one, but, down to a very recent period, the sole idea of utilising the power there was by constructing surface canals, and dropping the water from them through turbines to subterranean tunnels, and so carrying the water away to the lower river. That plan was absolutely feasible from an engineering point of view, but would certainly fail in a financial aspect. The whole conception of the project changed from the moment t became apparent that it was possible to create the power in very large quantities at one place, and then to transmit it where it was wanted; and the success of the enterprise was dependent upon the cheapness with which electrical engineers were able to carry off the power from the power-house to stations at greater or less distances. The hydraulic part of the programme presented no insuperable difficulty. There were only two difficulties about it: the first was the financial difficulty of finding people bold enough to begin work on a sufficiently large scale. It was no use undertaking a work of this kind for a few horse-power; but the boldness of undertaking the building of a tunnel of 100,000 horse-power was not always to be found, still it was essential to the success of the work. That was one difficulty; and the second was merely the construction of ordinary hydraulic machinery, on a somewhat larger scale than it had ever been constructed before. In absolute size, he was not aware that the turbines which had been put in at Niagara were so large as others that had been constructed. He did not know that there were any of more than 1,000 or 1,200 horse-power at most; but from that to the proposed 6,000 was a great step, and, of course, the straining action would be greater than that in any existing turbines. The conditions there were extremely favourable for the turbines; there was a fall of admirable character, neither too big nor too little, and there were no difficulties in the design of the turbines except that, taking into account the position, they must be built on rather a big scale. The one practical difficulty which did arise of overcoming the weight of the revolving parts which had to be carried could be met, and had been met, by the method adopted in many cases by Messrs. Ricard Brothers, in Switzerland, and others, of carrying the greater portion of them hydraulically. There was no question whatever that at Niagara power would be obtained from the turbines at an exceedingly small cost reckoned at per horse-power per annum, and on the Canadian side they would obtain it at even less cost. Then would come, in addition, the expense of the transfer of the power to the points where it would have to be used, but of that he was not at all competent to speak; as far as one could judge at all, they would be able to supply power even at Buffalo at a price below that at which steam-power could be got to compete with it. On that point he would only say that the flow of power reckoned, at per horse-power per annum, depended a good deal upon the shape in which it was obtained; if it came in an inconvenient shape it would not be worth very much, but if it came in a convenient way it might be worth a great deal. In London there were some 6,000 horse-power, which was sold at a price of £20 or £30 per horse-power per annum at the Hydraulic Company's mains, and the reason of the price being fixed was that it came in a shape which was particularly convenient for the purpose for which it was used. If the power were transmitted electrically there was no doubt that it would be transmitted in a very convenient shape. The cost of power at Buffalo was not much less than that of the best steam engines constructed on a large scale, and it was much greater where there were a number of small engines scattered over many small workshops; but the introduction of electric machinery would enable the power to be transmitted to just where it was wanted, without the intervention of further transmitting machinery. Looking at the drawings of the machinery at the Herbstal Works in Belgium, with regard to transmitting power, it would be seen how that was carried out by belting and other means. It would be fair to take the value at the points where it was used—not to compare it with the cost per horse-power obtained in an engine-room, but with the cost of the power when it gets to the working machinery. The portion of the power which was to be used at Niagara at present was a very small fraction, so that, as Professor Forbes had said, they were not likely to lose sight of Niagara, but he thought the Americans would not leave it alone until it had of itself become a mere rocky dell.

Col. Allan Cunningham had nothing to add upon technical points, but on the side issues he could not help regretting, as a Briton, hat this work had all been done on the American side, and that all the advantages were to be on that side. It was true that even more would eventually be taken out of the river on the Canadian side, but it appeared that none of the lands of the Cataract Construction Company were on that side, and it seemed, from what had been said, that all the advantages would go to the Americans. However, he hoped that would not be so, but that Canada would be able to utilise the power on her own side. The project for utilising this very large body of water, and the grand manner in which it had been carried out, led one to hope that it would now be possible to do the same all over the world. The discharge was stated to be about 280 cubic feet per second, but that was only one-fortieth of the discharge of the Great Ganges Canal in India. Three miles from Roorkee that large body of water fell over a height of eight feet. The great workshops there were worked by coal obtained from a great distance, and it was a question whether that water could not be utilised. At the time he

resided there it could not, but now it was seen that a mode of carrying the power gained from water to a great distance had been made practicable in both an engineering and economical or commercial sense which could be easily adopted. That was only one place in which he happened to be interested, and, of course, it could be done in other directions. The size of this work was immense: for instance, the inlet was 500 feet wide and 12 feet deep. It used to be considered that the Ganges Canal was the largest in the world, 100 feet wide and 10 feet deep; but it was true that this (Niagara) canal was 1,500 feet long. With that great length of tunnel, if the fall of the tunnel was considerable, the velocity of the water passing through it must be very great indeed, and the wear and tear upon the brickwork would be enormous.

Professor FORBES, in reply, said, with regard to the question of utilising the power on the Canadian side, there was every prospect that the power, which would be double that on the other side, would be developed fully as much as on the American side; but the difficulty was to find customers for it. The nearest centre of industry to that spot was Buffalo, and the route to Buffalo from the Canadian side of the Falls was shorter than from the American side, and very likely, therefore, it would be supplied from that side, and it was perfectly easy to use the two sides where the power was generated, as well as one, to work together and assist each other for whatever purposes it might be required. If the Canadians possessed manufacturing districts close enough, or if they had the energy to start a manufacturing centre in the immediate neighbourhood, the power could easily be delivered, but he feared there was hardly the same go in Canada as there was only a few hundred yards away in the United States. From a patriotic point of view it distressed him every time he went there. The only other point asked was as to the velocity. The head of water was very great, and the velocity would be about 25 feet per second, which was a very high velocity; but the greatest precautions had been taken in the construction of the tunnel, and he did not think it was likely to suffer any damage.

The CHAIRMAN then proposed a hearty vote of thanks to Professor Forbes for his most interesting paper. It was a subject which he had often thought about from an amateur point of view, and to see that the scheme had already been so rapidly developed into practical working, was a matter of great satisfaction. He should have been glad if those present had been able to discuss a little more the electrical side of the question, because they all took an immense deal of interest in the electrical transmission of power, and he should have been glad to hear the views of experts as to the feasibility of transmitting and distributing, at an economical rate, the enormous volume of power which Prof. Forbes had spoken of. However, for obvious reasons, he had felt compelled to abstain from discussing electrical details, which must form the subject of actual negotiations and contracts in the course of a few weeks. The paper was conceived in a very comprehensive spirit, and brought forcibly, and almost visibly, before the audience the magnitude of the undertaking and the extraordinary pains that had been taken to make it a success, and he was quite sure every one would unite in passing a cordial vote of thanks.

The vote of thanks was carried unanimously, and the meeting adjourned.

Miscellaneous.

FOREST PRODUCTS OF BRITISH GUIANA.

In 1890, the exports of timber from British Guiana amounted to 332,098 cubic feet, valued at 110,000 dollars, and, in 1891, to 312,801 cubic feet, valued at 96,330 dollars. The United States Consul at Demerara says that this industry could be developed to almost any extent, if the difficulty of the rapids were overcome, so that timber could be easily brought down from the interior. At present, little or nothing can be done beyond the rapids, so that only a very small portion of the country can be profitably worked. Another product of the forest is ballata, a kind of gutta-percha, which was exported in 1890 to the amount of 226,809 pounds. Shingles, firewood, and charcoal are also exported to a small extent, principally to Barbados. The forests embrace a great many species of trees. The varieties of timber are, as a result, numerous in colour—from dark red to almost pure white—and, in specific gravity, from nearly double that of water to less than half that of the standard liquid. The principal building woods are green heart, mora, and wallaba. The first is a most valuable wood, being classed with teak, either one of which may be exclusively used in shipbuilding, while its durable qualities are placed on a level with oak, only teak coming before it. It is heavy, very close grained, grey, with a greenish cast, and may be obtained 50 or more feet in length. Under water and in the tropics it is superior to all other woods, house frames, made of green heart which are 100 years old, having been found still unperforated by worms. The mora is not so close-grained as green heart, but it is almost equally durable. Its colour is reddish, and it may be obtained in as large dimensions as green heart. Wallaba is a dark red wood, with an unpleasant odour when new, very durable, but not obtainable in such large sized logs as those referred to above.

Being easily split, it is commonly used for making shingles, palings, cask and vat staves, &c. On account of its colour and smell, it cannot be used for rum puncheons, but, after a little use, water makes no impression upon it. Other timbers are particularly suited for special purposes, such as that of the bullet tree, which was formerly considered the only timber fit to be used for the arms and shafts of windmills. The silverbally is light, and suitable for boat building, from its containing a bitter element obnoxious to worms and barnacles. As to the woods suitable for furniture, these, it is said, will no doubt be better appreciated in other parts of the world, when they are known a little better than at present. The native cedar (*cedrela*), which is quite different from the timber of trees of the pine family, is very useful for wardrobes and cabinets, where its scent tends to keep away insects. Mahogany is not native to the colony, but the wood called Guiana mahogany is that of the *carapa*, commonly known as crab wood. It is not so dark in colour or so hard in texture as mahogany, and, being more easily worked, is used for all kinds of furniture. Letterwood is one of the prettiest, but, as the peculiar dark marks are only found in the heart, only small logs can be obtained, rarely exceeding six inches in diameter. Purple heart is unique, being of a pretty violet colour, when fresh or new, which, however, turns to a dark brown after being worked up. There are many different varieties of furniture woods produced in British Guiana, and a list, enumerating 63 distinct kinds, was prepared for the Paris Exhibition of 1878. In the various woods every colour known is represented, from almost black, through browns and reds to deep and pale yellow, to almost white. They are, however, curiously free from irregular veining and knots, the marks being almost uniform and in parallel lines, but they are not wanting in beauty. For panelling, nothing can excel the nearly black wamara, contrasted with the pale green heart or the lighter and more easily worked simarupa, which is almost white. At present, the demand is so limited that many of the fancy woods are difficult to procure, the woodcutters looking only for such timber as they know will command a market. If, however, says Consul Carrol, a market were opened, these could be collected as easily as green heart, mora, and wallaba are at present.

General Notes.

Indian Section.—The first meeting of this section will be held a week earlier than the date already announced. This will be on January 12th, when Mr. H. Thirkell White, C.I.E., will read a paper on "Upper Burma under British Rule." On January 19th, Mr. J. Barr Robertson will read a paper on "The Currency Problem."

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 19...Geographical, University of London, Burlington-gardens, W., 8½ p.m. Captain F. G. Dundas, "Expedition up the Juba River, through Somali Land."

British Architects, 9, Conduit-street, W., 8 p.m. Dr. William Dörpfeld, "The Hypæthral Temple."

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. A. Mitchell, "Towers and Steeples."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. E. Tidman, "Sanitary Ventilation."

Tuesday, Dec. 20...Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. John Rigby's Paper, "The Manufacture of Small Arms." 2. Mr. J. Emerson Dowson, "Gas-Power for Electric Lighting."

Statistical, School of Mines, Jermyn-street, S.W. 7¾ p.m. Mr. J. A. Baines, "Distribution and Movement of the Population in India."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. Hans Gadow, "The Remains of some Gigantic Land Tortoises and of *Didosaurus* recently discovered in Mauritius." 2. Rev. T. R. R. Stebbing, "Description of Nine New Species of Amphipoda from the Tropical Atlantic." 3. Mr. F. E. Beddard, "Some New Species of Worms of the Family Acanthodrilidæ and of the Genus *Perionyx* and other Genera."

Wednesday, Dec 21....Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. H. C. Russell, "Moving Anticyclones in the Southern Hemisphere." 2. Capt. M. W. C. Hepworth, "The Tracks of Ocean Wind Systems in Transit over Australasia." 3. Dr. Nils Ekholm, "A New Instrument for Cloud Measurements." 4. Mr. Henry Mellish, "Rainfall of Nottinghamshire, 1861-90."

Microscopical, 20, Hanover-square, W., 8 p.m. 1 Mr. J. Hood, "New Species of Rotifera." 2. Mr. E. M. Nelson, "The Chromatic Curves of Microscope Lenses."

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Geological, Burlington-house, W., 8 p.m. 1. Mr. R. Lydekker, "A Sauropodous Dinosaurian Vertebra from the Wealden of Hastings." 2. Rev. P. B. Brodie, "Some additional Remains of Cestraciont, and other Fish, in the Gritty Marls immediately overlying the Red Marls of the Upper Keuper in Warwickshire." 3. Mr. Thos. Hick, "*Calamostachys Binneyana*, Schimp" (communicated by Mr. J. W. Davis). 4. Mr. W. S. Greesley, "Notes on some Pennsylvanian Calamites." 5. Herr Victor Madsen, "Scandinavian Boulders at Cromer" (communicated by Mr. J. W. Hulke).

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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FRIDAY, DECEMBER 23, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 4 and 11, by R. Bowdler Sharpe, LL.D., on "The Curiosities of Bird Life."

The lectures will commence at seven o'clock. Members requiring tickets are requested to make early application for the few that still remain.

As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

STOCK PRIZE.

No award of this prize was made this year, as the Examiners in the National Competition of the Department of Science and Art reported that no work was submitted to them which fulfilled the conditions laid down for drawings.

The Gold Medal, or prize of £20, is offered for competition amongst students of the Schools of Art of the United Kingdom at the annual National Competition held in 1893.

The conditions of the offer will be given in the *Journal* next week, or can be had on application to the Secretary.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a Prize of £20 for competition amongst students of the Schools of Art of the United Kingdom, at the annual National Competition held in 1893.

The Prize is offered to the student who obtains the highest awards in the following subjects :—

(*a*) A finished drawing of imperial size from the nude living model.

(*b*) A set of time studies from the nude living model (mounted on imperial size mounts).

(*c*) A set of studies of hands and feet from the living model (mounted on imperial size mounts).

(*d*) Drawing from the life done at the examination on May 11th, 1893.

No student will be eligible for the award who does not pass in the examination *(d)* in drawing from the life, and who does not obtain an award for *(a)* the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The drawings, &c., are to be submitted, with other school works, in the usual manner to the Department of Science and Art, in April, 1893. Each competing drawing must be marked, "In competition for the Mulready Prize," *in addition* to being labelled according to the regulations of the Department of Science and Art.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d., on application to the Secretary.

Chicago Exhibition, 1893.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Tuesday, 20th inst. Present: Sir Frederick Abel, K.C.B., D.C.L., F.R.S., in the chair; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, James Dredge, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., John O'Connor, with Sir Henry Trueman Wood, M.A., Secretary to the Commission.

PHOTOGRAPHIC COMMITTEE.

A meeting of the Committee on Photography was held on Thursday, 15th inst. Present: Francis Cobb, in the chair; Captain W. de W. Abney, C.B., F.R.S., George Davison, James Dredge, F. Leyton Scott, with Sir Henry Trueman Wood, Secretary to the Commission.

FINE ARTS COMMITTEE.

A meeting of the Committee on Fine Arts was held on Friday, 16th inst. Present: Sir Frederick Leighton, Bart., P.R.A., in the chair; J. Macvicar Anderson, P.R.Inst.B.A., Wyke Bayliss, P.R.Soc.B.A., Philip H. Calderon, R.A., Henry W. B. Davis, R.A., Sir James D. Linton, P.R.I., W. E. Lockhart, H. Stacy Marks, R.A., W. Ouless, R.A., Edward J. Poynter, R.A., Marcus Stone, R.A., Sir Henry Trueman Wood, Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

Proceedings of the Society.

CANTOR LECTURES.

GENERATION OF LIGHT FROM COAL GAS.

By Vivian B. Lewes, F.I.C., F.C.S.,
Professor of Chemistry, Royal Naval College.

Lecture I.—Delivered November 21, 1892.

If any excuse were needed for choosing the development of light from coal gas as the subject for this course of lectures, I can conceive no better one than that we have now completed the first hundred years of gas-lighting, and that it behoves us to review what has been done in the past, and may yet be done in the future; to survey and criticise the position of our great gaseous illuminant, and to see how far its position is likely to be assailed, and how far the weak points in that position may be strengthened.

The centenary of gas-lighting awakes many thoughts of the past, and as we review the early struggles and final victory of gaseous illumination, we cannot help feeling that, complete as the victory has been, many changes will have to be made in the future to insure the advantages which have been so hardly won.

It is to the past that we must turn to see the way in which the experimental data upon which we found our present methods of burning gas were obtained, and also to ascertain if any threads of the tangled skein still remain to be unravelled.

The close of the last century was marked by a wonderful wave of scientific activity, which swept over western Europe, and it was at this period that the county of Cornwall held two men, destined to shed "an immensity of light," in more ways than one, over the civilised world.

In 1779, William Murdoch, then in his twenty-fifth year—having been born in Ayrshire in 1754—went to Cornwall as superintendent-manager to Messrs. Boulton and Watt, to introduce their engines in the Cornish mines; and it was whilst employed in this way that he conceived the idea of making illuminating gas by the distillation of coal, an idea which culminated in 1792 by his lighting up his house and office in Cross-street, Redruth, with coal gas made in a primitive form of retort in the back yard. It was thus that, 100 years ago, Murdoch earned his title to fame by the introduction of one of the most useful applications of the past century, and had it not been for the opposition and obstacles thrown in his way by Watt, he would have added a still greater lustre to his name by perfecting the locomotive many years before Stephenson.

At the same time that Murdoch was working at Redruth, manufacturing and introducing coal gas, Cornwall contained another most important living factor in the history of gaseous illumination. Far away, at the south-western extremity of England, the town of Penzance nestles on the shore of Mount's Bay, and here it was that, on the 17th of December, 1778, Grace Davy, the wife of a prominent citizen, Robert Davy, gave birth to a son, who lived to achieve the highest pinnacle of scientific fame, and to shed a lustre on the chemical work done in the early days of the present century.

The name of Sir Humphry Davy conjures up to the mind one of the most remarkable men, in many ways, that the past century of scientific work has developed, and in no way more remarkable than in the intensity, rapidity, and variety of the work he did. Even in his schooldays he dabbled in poetry, metaphysics, and theology, whilst at the age of nineteen he commenced to work at chemistry, and achieved a success as phenomenal in its rapidity as it was well deserved.

It was in the year 1797 that the first impulse was given to his mind towards science by reading Lavoisier's "Elements of Chemistry,"

and not satisfied by merely acquiring the ideas of the great French philosopher, he was led on to experiment for himself, and prospered so rapidly, that, in spite of his laboratory being his bedroom, and his apparatus a heterogeneous collection of domestic *flotsam* and *jetsam*—phials, old pickle-bottles, wine-glasses, and tobacco-pipes—his genius did what no amount of costly apparatus could have done, and within four months of his commencing to work at science, he had also commenced writing an essay on "Heat and Light" which was published in 1799. Already by 1799 he had made such strides in his chemical knowledge, that he left Penzance and went to Clifton as superintendent of the Pneumatic Institution, established there by Dr. Beddoes, for the purpose of trying the medicinal effect of various gases, and although there only a couple of years, he published no less than nine researches and essays upon heat, light, galvanism, the properties of nitrous oxide, and respiration.

In the commencement of 1801 he became assistant lecturer on chemistry at the Royal Institution, and having made a deep impression by his powers as a lecturer, became Professor there on the 31st of May, 1802—some five years after his first introduction to the science. The intensity which he threw into his work is not only evidenced in this extraordinary personal success, but is also shown in the marvellous rapidity with which many of his most important and successful researches were carried out. It is in conjunction with the safety lamp that his memory is most widely connected, yet the whole of that research, culminating as it did in a thoroughly successful application of science to practical utility, only took a few months.

In August, 1815, his attention was first directed to the subject of fire-damp whilst on a shooting expedition in the Highlands. On his way back to town he stopped at Newcastle, and made inquiries into the circumstances connected with explosions in mines, and arranged for some fire-damp to be sent to him in London. He then entered into the investigation, and on November the 9th the results of his inquiries were given in a paper read before the Royal Society, and the principle of the safety-lamp was laid down, the lamp itself being perfected the following month.

Davy reigned at the Royal Institution until 1812, when he began to feel that lecturing interfered with the researches upon which his mind was bent, and having married and received the honour of knighthood, he retired that year and devoted his time to scientific work, until, on the death of Sir Joseph Banks in 1820, he became President of the Royal Society. He still continued his researches, until his early death in 1829 robbed science of one of her most brilliant sons.

Of his innumerable researches there is one which links his name with that of Murdoch and the early pioneers of the great gas industry, a research which, springing out of his investigations on fire-damp, gave us the first and fundamental theory of the causes of luminosity in a gas flame, a theory which remained unquestioned and unchallenged for 50 years, and the broad principles of which all modern research goes to confirm.

The first published work upon this subject is dated July, 1816, and consists of a "Notice of some New Views and Experiments respecting Flame," published in the "Journal of Science and the Arts," a paper edited at the Royal Institution, in the second volume of which, p. 124, the following passages occur:—

"When a wire-gauze safety lamp is made to burn in a very explosive mixture of coal gas and air, the light is feeble and of a pale colour, whereas the flame of a current of coal gas burnt in the atmosphere, as is well known by the phenomena of gas lights, is extremely brilliant. In a paper read before the Royal Society, I have endeavoured to show that, in all cases, flame is a continued combustion of explosive mixtures; it becomes therefore a problem of some interest, 'Why the combustion of explosive mixtures, under different circumstances, should produce such different appearances?' A very acute philosopher, who himself started the subject in conversation, suggested the idea that in the combustion of explosive mixtures within the lamp, carbonic oxide might be formed, and that the light might be deficient from the deficiency of the quantity of oxygen necessary to produce carbonic acid. On submitting this idea to the test of experiment, it was discovered to be unfounded, for, by the combustion in the wire-gauze lamp, carbonic acid was produced in quantities as great as could have been expected from the quantity of oxygen consumed, and on adding oxygen to a mixture in quantities more than sufficient to burn the whole of the gas, the character of the light still continued the same.

"In reflecting on the circumstances of the two species of combustion, I was led to imagine that the cause of the superiority of the light of the stream of coal gas might be owing to the decomposition of a part of the gas towards the interior of the flame where the air was in smallest quantity, and the deposition of solid charcoal, which, first by its ignition and afterwards by its combustion, increased in a high degree the intensity of the light, and a few experi-

ments soon convinced me that this was the true solution of the problem.

"I held a piece of wire-gauze of about 900 apertures to the square inch over a stream of coal gas issuing from a small pipe, and inflamed the gas above the wire-gauze, which was almost in contact with the orifice of the pipe, when it burnt with its usual bright light. On raising the wire-gauze so as to cause the gas to be mixed with more air before it inflamed, the light became feebler, and at a certain distance the flame assumed the precise character of that of an explosive mixture burning within the lamp; but though the light was so feeble in this last case the heat was greater than when the light was much more vivid, and a piece of wire of platinum held in this feeble blue flame became instantly white hot.

"On reversing the experiment, by inflaming a stream of coal gas and passing a piece of wire-gauze gradually from the summit of the flame to the orifice of the pipe, the result was still more instructive, for it was found that the apex of the flame intercepted by the wire-gauze afforded no solid charcoal; but in passing it downwards solid charcoal was given off in considerable quantities, and prevented from burning by the cooling agency of the wire-gauze, and at the bottom of the flame, where the gas burnt blue in its immediate contact with the atmosphere, charcoal ceased to be deposited in visible quantities.

"This principle of the increase of the brilliancy and density of the flame by the production and ignition of solid matter, appears to admit of many applications.

"1st. It explains readily the appearance of the different parts of the flames of burning bodies, and of flame urged by the blow-pipe—the point of the inner blue flame where the heat is greatest is the point where the whole of the charcoal is burnt in its gaseous combinations without previous deposition.

"2ndly. It explains the intensity of the light of those *flames* in which *fixed* solid matter is produced in combustion, such as the flame of phosphorus,* and of zinc in oxygen, &c., and of potassium in chlorine, and the feebleness of the light of those flames in which gaseous and volatile matter alone is produced, such as those of hydrogen and sulphur in oxygen, phosphorus in chlorine, &c.

"3rdly. It offers the means of increasing the light of certain burning substances, by placing in their flames even combustible substances. Thus, the intensity of the light of burning sulphur, carbonic oxide, &c., is wonderfully increased by throwing into them oxide of zinc, or by placing in them very fine amianthus or metallic gauze."

* Sir Humphry Davy adds to this the following important footnote:—"Since this paper has been written, I have found that phosphoric acid volatilises slowly at a strong red heat, but under moderate pressure it bears a white heat, and in a flame so intense as that of phosphorus, the elastic force must produce the effect of compression."

In the same paper he also points out that—

"When cuprane, or protochloride of copper, is introduced into the flame of a candle or lamp, it affords a peculiar dense and brilliant red light, tinged with green and blue towards the edges, which seems to depend upon the chlorine being separated from the copper by the hydrogen, and the ignition and combustion of the solid copper and charcoal."

Further on in the same paper, he says:—

"Whenever a flame is remarkably brilliant and dense, it may always be concluded that some solid matter is produced in it; on the contrary, when a flame is extremely feeble and transparent, it may be inferred that no solid matter is formed."

And concludes by pointing out that—

"The heat of flames may be actually demonstrated by increasing their light—at least the heat communicable to other matter—and *vice versa.* The flame from combustion which produces the most intense heat amongst those I have examined is that of a mixture of oxygen and hydrogen in slight excess, compressed in a blow-pipe apparatus, and inflamed from a tube having a small aperture. This flame is hardly visible in bright daylight, yet it instantly fuses very refractory bodies, and the light from solid matters ignited in it is so vivid as to be painful to the eye."

In another paper, read before the Royal Society in the following year, he refers to the work I have just brought before you, and says:—

"I have given an account of some new results on flame, which show that the intensity of the light of flames depends principally upon the production and ignition of solid matter in combustion, and that the heat and light in this process are in a great measure independent phenomena."

He then goes on describe the effect of rarefaction upon flame and explosion, and the checking effect which the admixture of various gases has upon combustion, in which connection he shows that the lower the temperature needed to bring about the combustion, the larger will be the quantity of admixed and diluting gases necessary to prevent combustion, a fact which he illustrates as follows:—

"There is a simple experiment which demonstrates in an elegant manner this general principle. Into a long bottle with a narrow mouth introduce a lighted taper, and let it burn till it is extinguished. Carefully stop the bottle, and introduce another lighted taper, It will be extinguished before it reaches the bottom of the neck. Then introduce a small tube containing zinc and diluted sulphuric acid, and at the aperture of which the hydrogen is inflamed, the hydrogen will be found to burn in whatever part of the bottle the tube is placed. After the hydrogen is

extinguished, introduce lighted sulphur, this will burn for some time, and after its extinction, phosphorus will be as luminous as in the air, and if heated in the bottle, will produce a pale yellow flame of considerable density."

He then proceeds to demonstrate the principles which led to the safety lamp, and in introducing the subject, says:—

"Flame is gaseous matter heated so highly as to be luminous, and that to a degree of temperature beyond the white heat of solid bodies, as is shown by the circumstance that flame not luminous will communicate this degree of heat. This is proved by the simple experiment of holding a fine wire of platinum about the one-twentieth of an inch from the exterior of the middle of the flame of a spirit lamp, and concealing the flame by an opaque body, the wire will become white hot in a space where there is no visible light."

Again, towards the end of the paper, he sums up his ideas on the luminosity of flames as follows:—

"The circumstances mentioned in this paper, combined with those noticed in the paper on flame, printed in Mr. Brande's 'Journal of Science and the Arts,' explain the nature of the limit of flames and their form. When in flames pure gaseous matter is burnt, the light is extremely feeble, the density of a common flame is proportional to the quantity of solid charcoal first deposited and afterwards burnt. The form of the flame is conical, because the greatest heat is in the centre of the explosive matter. In looking steadfastly at the flame, the part where the combustible matter is volatilised is seen, and it appears dark contrasted with the part in which it begins to burn, that is, where it is so mixed with air as to become explosive. The heat diminishes towards the top of the flame, because in this part the quantity of oxygen is least. When the wick increases to a considerable size from collecting charcoal, it cools the flame by radiation, and prevents a proper quantity of air from mixing with its central part. In consequence, the charcoal thrown off from the top of the flame is only red hot, and the greater part of it escapes unconsumed.

"The intensity of the light of flames in the atmosphere is increased by condensation and diminished by rarefaction, apparently in a higher ratio than their heat; more particles capable of emitting light exist in the denser atmospheres, and yet most of these particles in becoming capable of emitting light absorb heat, which could not be the case in a condensation of a pure supporting medium."

Let us now collect the theories enunciated in this masterly work, and see to what point it has carried our theory of flame and its luminosity.

1. The light emitted by coal gas is due to the decomposition of a part of the gas towards the interior of the flame where the air is in smallest quantity, and the deposition of solid carbon which, first by its ignition and afterwards by its combustion, increases to a high degree the intensity of the light.

2. The point of the inner blue flame in a blowpipe where the heat is greatest, is the point where the whole of the charcoal is burnt in its gaseous combinations without previous deposition.

3. When in flames pure gaseous matter is burnt, the light is extremely feeble.

Taking these enunciations as they stand, there is little cause to wonder that no marked opposition was raised to them for upwards of fifty years, and that when the opposition came it should have strengthened rather than weakened the edifice erected by the master hand.

The attention bestowed upon the subject of flame and the causes of its luminosity was small indeed during the next thirty-five years, and very little was done beyond some work by Berzelius about 1820 upon the structure of flame, and a paper by Waldie, published in the "Philosophical Magazine" for 1838—the experimental portion of which, however, was mostly not new, having been done by Kemp in 1833—who showed what may be termed the phenomenon of reciprocal combustion, *i.e.*, that the terms combustible and supporter of combustion being relative, it is as easy to burn a jet of oxygen in an atmosphere of hydrogen, as the more ordinary case of hydrogen in oxygen.

The general theory put forward first by Berzelius, as to the structure of flame, and which exists to the present time, is best given in his own words:—

"If we attentively consider the flame of a candle we may remark several unequal divisions of it, of which four may be distinguished. We see at its base a small part of a dark blue colour, which becomes thinner as it gets farther from the wick, and disappears entirely when the external surface of the flame ascends perpendicularly. In the middle of the flame is a dark place seen through its brilliant covering. This space encloses the gases which issue from the wick, which, not being yet in contact with the air, cannot undergo combustion. Round this space is the brilliant part of the flame properly so called, and lastly beyond this we may perceive, by attentive inspection, the outer covering of all, slightly luminous, and whose greater thickness corresponds with the summit of the brilliant flame. It is in this outer part that the combustion of gases is completed and the heat the most intense."

Important researches were made upon the chemical changes taking place in luminous and other flames during the "fifties" which will be considered later, and in 1861 Dr. O. Kersten published a paper in the "Journal fur practische Chemie," in which he challenged a theory started by Graham-Otto some years before, that the carbon particles which gave luminosity to a flame of gaseous hydrocarbons are liberated by the greater affinity of the oxygen for the hydrogen of the molecule, which burns first and so sets the carbon free, and he shows that by exploding ethylene with a limited quantity of oxygen or electrolytic gas that oxides of carbon are formed, and hydrogen, not carbon, liberated. From which he reasons that in a flame preferential combustion of carbon is an important factor and not preferential combustion of hydrogen.

All observations, however, show that any theory of "preferential combustion," be it of hydrogen or carbon, are totally apart from the causes which give rise to the liberation of the all-important carbon particles in the flame. An idea seems to exist that certain parts of a complex molecule can be eaten away by other bodies which have an affinity for it, but this is in the present case an error. In a hydrocarbon molecule or particle, neither hydrogen nor carbon exist as such, and before the affinities of these elements come into play the complex molecule must be broken into its constituents, and Sir Humphry Davy's original statement is the true solution, that if the temperature of a flame is not sufficient to decompose the hydrocarbon into its elements and thus liberate carbon, the hydrocarbon burns as a whole, and with a non-luminous flame.

Miscellaneous.

ENGINEERING CONGRESS AT CHICAGO EXHIBITION.

It has been decided to hold an Engineering Congress in connection with the World's Fair at Chicago next year, from Monday, July 31st, to Saturday, August 5th. With the aid of the more important engineering societies of America, a strong committee has been formed for the purpose of making all the necessary arrangements, and it is intended to invite papers from leading engineers on their special branches of engineering science. It is intended, as far as possible, to have the papers printed early in the year, so that copies can be obtained, though not for publication, by those desiring to take part in the discussions which are to be held on the papers. The latter are to be read in abstract only, which will save valuable time for the discussions. Papers on new and important constructions, machines and processes, experiments and investigations, will be welcomed from all, but such papers will only be accepted for reading on the advice of the officers in charge of the arrangements for that particular division of engineering to which the paper relates. All the papers will be published in English; those in other languages, if accepted, will be translated, but the discussions may be in French, Spanish, or German, as well as in English, interpreters being provided when necessary. Formal invitations to participate in the Congress will be issued to all the leading engineers of the world, and it is to be hoped that a good proportion of British will find themselves able to accept. The entire proceedings of the Congress will be published, and copies sold at cost price to engineers who may subscribe for them. At the close of the Congress a number of excursions will be made to points of engineering interest, the details of which have not yet been settled. To facilitate the work, the Congress has been divided into seven divisions, as follows:—Division A, Civil Engineering; Division B, Mechanical Engineering; Division C, Mining Engineering; Division D, Metallurgical Engineering; Division E, Engineering Education; Division F, Military Engineering; Division G, Marine and Naval Engineering.—*Engineering.*

TRADE OF PERSIA.

M. A. J. Ceyp, who contributes an article to the *Handels Museum* of 27th October, attributes the backward condition of commerce in Persia to the neglect of the shipping trade on the Persian Gulf and Caspian Sea, the stoppage of transit trade by Russia, and the wretched condition of the roads, which are very much neglected. Persia has for the last 38 years been prohibited from having any ships on the Caspian Sea.

The bulk of the trade is carried on with Russia, Turkey, Bokhara, Afghanistan, India, and Arabia. The Russians trade chiefly by way of the Caspian port of Enzeli, but fresh routes are now open from the Black Sea through Russian Armenia and Georgia.

Trade with Turkey is carried on by way of Bagdad and Erzeroum. Weekly caravans pass between Trapezunt and Tabriz with consignments of English cotton goods, Bohemian glass, Austrian cloths, furs from the fair at Leipzic, and toys from Nüremberg. The distance traversed by caravans is 611 miles, the caravans themselves varying in strength between 200 and 900 horses. Mules are seldom employed, and camels scarcely at all Northern Persia and Central Asia grow less profitable every year as markets, while smuggling opera-

tions with the Transcaucasian provinces of Russia are becoming more extensive and profitable. Nearly one-half of the goods imported *viâ* Trapezunt and Erzeroum remain in the depôts of Tabriz at the disposal of Russo-Armenian smugglers, after which they are transported across the Araxes.

The falling off of Russian trade with Persia has of late excited comment. One of its chief causes is the fact that the prices of Russian manufactured goods have in recent years risen to the extent of from 15 to 25 per cent., thus making it difficult to compete with English goods, which have somewhat fallen in price. There has also been a considerable fall in the value of the Russian half-imperial and in silver bars. This enables the Persians to dispense with Russian manufactures and to devote themselves to financial operations, which are attended by scarcely any risk. They buy Russian half-imperials and Russian silver bars in large quantities. Persians having Russian gold and silver at their command, obtain in their country 3 kerân and 14 shâhî (equivalent in Russian money to 1 rouble and 11 copecks, according to the exchange at Baku) for each credit rouble, thus securing a profit of 11 copecks per rouble.

The Russians have a very complicated task to perform in Persia. The Government of this semi-barbarous country is exceedingly anxious to promote its civilisation, to increase its material welfare, to spread enlightenment, and, in short, to bring about a general improvement in its conditions of life. Under such circumstances, if Russia desires a maintenance of friendly relations with Persia, she is bound not only to refrain from obstructing her in her mission of civilisation, but even to use every endeavour for furthering this end. This is so much the easier inasmuch as Russia herseif has an interest in the advance of civilisation in Persia; and yet this very side of the question does not receive at her hands the attention which it merits. Opposing free trade in their own dominions, the Russians expect friendly States to adopt a similar policy when by doing so Russian commercial interests are to be benefited. Protection forces Russian manufacturers to confine themselves to the production of inferior and dearer goods. Persia is expected to close her frontiers to all European nationalties and to purchase Russian goods exclusively, while the Russians make no endeavour to cheapen them for the Persians. The conditions of transport from Russia are the same as they were half a century ago. England brought about the opening of the River Kuran to all European nations, while Russia has made no effort towards making her wares preponderate in Tabriz, which is so close to her frontier. So little has she exerted herself in this direction, that English goods compete with those of Russia in Tabriz itself, notwithstanding the difficulties and dangers attending their transport *viâ* Bagdad, necessitating a journey of 473 miles.

The opening of the Karun would constitute no menace to the commercial interests of Russia if she would only improve the roads communicating with Northern Persia, and connect Teheran by railway with the Caspian Sea; then no serious competition with England need be feared.

British and Arabian vessels entering the Persian Gulf carry cargoes of wine, rose-water, dates, horses, wheat, barley, raw silk, medicinal plants, and drugs.

With the exception of the region along the Caspian Sea, where the climate is moist, the whole of Persia is adapted for the cultivation of opium. The Government of Ispahan exports from 4,500 to 5,000 boxes of opium, worth about £90 sterling each per annum; two-thirds of this is destined for China, and the remainder for London.

The average annual tobacco crop is about 36,000 packages, of which one-half is exported to Egypt and Syria *viâ* Bushire, about 20,000 packages to Constantinople *viâ* Tabriz, and 10,000 packages to Bagdad, Kurdistan, Khorassan, and Fars. Persia exports tobacco to the value of about £100,000 to England, America, and France. The pearl export trade, the annual value of which exceeds £500,000, is entirely in the hands of wealthy Orientals.

Persian imports, *viâ* Bushire, consist of European cloths, cochineal, indigo, iron, lead, tin, spices, tea, Chinese porcelain, Bengal muslins, dye-woods, white cottons, checked and printed linens, tanned leather, and Mocha coffee.

Persia imports sal-ammoniac, indigo, steel, and shawls from Afghanistan and Beloochistan, while her exports to these countries consist of coarse cloths, silk and cotton stuffs, linen, sugar, copper, and dried fruit.—*Board of Trade Journal.*

HORSE BREEDING AND HORSE BREAKING IN URUGUAY.

The British Vice-Consul at Montevideo says that horses in Uruguay are bred in a semi-wild state, and scattered over large tracts of land; it therefore requires time and labour to gather them together and drive them into the corral or stockyard. The whole work of branding, selecting colts for breaking in, and those mares that are to be sent to the slaughter-houses, cutting off mares' manes and tails (for horse-hair), &c., is done in the corral. The colts fit for taming and breaking in are singled out and lassoed. Strong raw-hide head-stalls are then put on their heads, and they are secured by these to posts set firmly in the ground, at which they tug and strain in vain efforts to break away. After they have been thus tied up for several hours, and have tired themselves out to a great extent, they are saddled by main force with the native saddle, called *recado.* This singular, though most useful, riding gear is also the Guacho's bed. It is as follows:—First two thick woollen cloths are placed on the back of the horse, and over these comes the raw-hide saddle-cloth. Then comes the seat, often made of wood, and not

unlike the tree of the ordinary English saddle, only it is the same width from the pommel to the cant, and covered with raw hide; the shape leaves room for free passage of air underneath, and room for the play of the backbone of the horse, thus sore backs are avoided. These are bound together by a strong girth (*cincha*) that goes round the animal, and is drawn tight by aid of rings and thongs; then comes a sheepskin, and finally over all a piece of water-hog skin, also tied on by a raw-hide surcingle. Stirrups are not used by the Guachos except on feast days and holidays. They prefer riding bare-footed and barelegged, and have a peculiar and facile method of vaulting on a horse even in motion, which enables them to mount without stirrups. The foot is rested, when riding, by grasping with the toes a thong that is knotted at the end, and that hangs from the saddle like ordinary stirrup leathers. The first bit that is put into the mouth of a young colt is simply a greased thong tied round the lower jaw of the animal, and the reins are fastened to this. This completes the riding paraphernalia of the Guacho. As soon as the animal has ceased trying to get rid of all this gear so strange to him, the rider takes him clear of the post and corral, and, seizing him firmly by the ear, springs into the saddle. Then follows a combat between horse and man, which ends, with rare exceptions, in favour of the latter. The colt is then unsaddled and tied firmly to the post, and left there until the evening, when he is again saddled and mounted. A second struggle takes place, but of a less severe nature, and, after several attempts to get rid of his rider, he, as a rule, submits to his new master. This primitive way of breaking in horses is not, however, carried out with the superior animal now being reared in the country by crossing with the English thorough-bred, as the system is too rough and dangerous, and thoroughly breaks the spirit of the animal. The Moorish ring bit is the one used for ordinary riding purposes, and, on account of its severity, a habit of riding with loose reins has been acquired by the horse-men of Uruguay. The animal never attempts to pull at the bridle for the same reason, but obeys instantaneously the slightest touch of the reins, and can be ridden by the merest child. Mares of the native breed are seldom if ever ridden, being, as a rule, small and unshapely. It is not an uncommon sight, says Vice-Consul Grenfell, to see a native Guacho (half caste Indian) present himself to be hired on an estate as *peon*, or farm servant, with a troop of ten to twelve horses of his own, all of which, if he is engaged, the employer has to keep for him in pasture, and which are never used in the ordinary work of the estate, the peon being provided with horses for that purpose by the owner of the property. In the spring of the year from thirty to forty young mares are selected in the corral, and one by one they are turned out to a stallion in waiting outside, who has been placed there for that purpose, and he immediately takes possession of them, and never leaves them; thus the various troops of mares are formed on the various estates, from whence the supply of horses is obtained in Uruguay. These animals possess much of the form of the Spanish horse, from which they sprang. They are tamed, as has been seen, with far less difficulty than might be thought possible, and, although theirs is the obedience of fear, and enforced at first by whip and spur, there are no horses who so soon and so perfectly exert their sagacity and their power in the service of man. They are possessed of no extraordinary speed, but are capable of enduring immense fatigue. They are frequently ridden sixty or seventy miles without drawing bit, and have, it is said, been ridden more than a hundred miles at the rate of twelve miles an hour. The value of the common horse of the country varies, but generally it may be put down as from £5 to £6 for broken in, quiet horses; for unbroken four year old colts, £1, and for mares, 10s.; the latter are seldom or never broken in. It is only during the last half-dozen years that any attempt has been made to improve the breed of horses in Uruguay. Thoroughbred horses and mares have been introduced on a limited scale, and those principally for racing purposes. A few shire horses and Clevelands have also found their way to the country, but as yet the result of these efforts to produce a better class of animal is hardly perceptible.

PRODUCTION OF VEGETABLE OILS IN FRANCE.

From the remotest antiquity, Marseilles has been the emporium not only of the oils of the province, but also of those produced by Italy, Spain, the African coast, Greece, and Turkey. The olive tree is cultivated in the following departments of France:—Alpes Maritimes, Var, Bouches du Rhone, Gard, Hérault, Aude, Pyrénées Orientales, Vaucluse, Basses Alpes, Drôme, and Ardèche. The total production is estimated at about 40,000,000 litres, representing a value of over 61,000,000 francs. The United States Consul at Marseilles says that of this quantity part is consumed within the district producing the oil, the remainder being sent into the interior of France or exported to neighbouring countries and the colonies. The import trade in oleaginous seeds is very considerable, the total quantity of the different kinds imported during the year 1890 being nearly 3,500,000 quintals. The most important importation of seeds consists of pea-nuts, by far the largest quantity of which arrive shelled, only about one-fifth of the total number imported having their shells on. This product comes for the most part from India and Africa. Afterwards, in order of importance, as shown by the quantity imported, come cocoanuts and palm-nuts; sesame from India and Africa; cotton seed, shelled pea-nuts, cultivated and wild rape seed, and sesame from the Levant; and finally linseed. The method followed in extracting

the oil from the various seeds imported at Marseilles, of the uses to which the oils are put, and the use made of the residuum are as follows:—The Levant sesame is subjected to three pressings, the seed being cold in the first two, but heated for the third, in order to allow of more oil being extracted. Before being pressed at all, the seed is thoroughly triturated, to allow the oil to come away more readily under pressure. In the first pressing, from 30 to 32 per cent. of oil is obtained, and this oil is sold at from 90 to 96 francs per 100 kilogrammes for table consumption. The seed is now thoroughly triturated again, a little water being added, and being again put under pressure, yields an oil inferior to the first, but which is quite good enough for eating purposes. After being removed from the press, the seed is once more thoroughly triturated, and from 2 to 4 per cent. of water is added to it, after which it is heated to a temperature of from 70° to 80° Centigrade, and the oil obtained is used in the manufacture of soap. The residuum is made into oilcakes, which are used for feeding cattle, and are sold at from 10 to 15 francs per ton. Indian and African sesame, like the Levant sesame, is subjected to three pressings, in the first two of which the seed is cold, and in the third heated. The oil yielded by the first and second pressings is used according to quality, either for table purposes or for lamp oil, and the oil obtained from the third pressing is used in the manufacture of soap. The residuum is made into oilcakes, which are used for feeding cattle, and also as fertilisers. These oilcakes are not quite so good in quality as those formed from the residuum of the Levant sesame. Pea-nuts are subjected to two pressings, and the yield of oil from the first is used in the manufacture of soap, and also for lubricating purposes. Poppy seed is pressed twice cold, and then heated and pressed once more. The yield of the first pressing is worth 70 francs per 100 kilogrammes, and is used for table purposes, and also, to a very considerable extent, in the manufacture of fine paints. The oil from the second crushing is used for table purposes, for making oil paints, and for burning; that from the third pressing is used almost exclusively in the manufacture of soap. Linseed is subjected to two pressings, in the first of which the seed is cold, and in the second heated. The yield of oil, in the first pressing, is 22 per cent. of the weight of the seed, and the oil obtained is used for table purposes, being sold at from 62 to 63 francs per 100 kilogrammes. After being triturated a second time, the seed receives the usual addition of about 2 per cent. of its weight of water, and is heated to a temperature of about 70° or 80° Centigrade, and is afterwards again placed in the press, when it gives forth 10 per cent. of its weight in oil of an inferior quality, which is chiefly used in the manufacture of soap. The residuum is made into oilcakes, which are of superior quality to those produced in the pressing of any other kind of seed. Egyptian cotton seed is thoroughly triturated, and then pressed twice. In the first pressing it is cold, and it yields from 10 to 12 per cent. of its weight in oil. The oil is destined for table purposes, and especially for mixing with olive oil, as it is perfectly tasteless, and, for this reason, many people also avail themselves of it for frying. It is sold at from 80 to 90 francs per 100 kilogrammes. The oil—from 8 to 10 per cent. of the seed in quantity—obtained in the second pressing, after the usual regrinding, watering, and heating, is of very inferior quality, and does not bring a higher price than about 50 francs per 100 kilogrammes. In the system of presses at present in use at Marseilles, the following is the process of manufacture for oil. The seeds are first put in a mill, where they are thoroughly triturated, by means of two upright stones or rollers, the object of this process being to allow the oil to be more readily expressed. The seed so crushed is then divided into several sacks or buckets, made of esparto grass and horsehair, and known as *scourtins*. These are placed one under another, with plates of iron between them, in the press, and, when pressure is applied, the oil forces its way through the baskets, and flows down their exterior surface into a receptacle placed below the press for the purpose of receiving it. The action of the press has frequently to be stopped, before the pressing is terminated, owing to some of the *scourtins* being pressed more on one side than on the other, so that they have to be re-adjusted before the operation can be continued. Care, moreover, has to be taken not to exceed a pressure of about 250 kilogrammes per square centimetre, equal, roughly, to 32 cwts. per square inch, as the *scourtins* will burst if strained to greater extent.

THE KHORASAN CARPET INDUSTRY.

Consul-General Elias, of Meshed, in a report just issued, says that carpets are made all over Khorasan, but the localities where they are specially produced are the city of Meshed, Birgand, and Turshiz. All Khorasan carpets are piled carpets, or *kalí*, a word that is not applicable to any other kind of floor covering. The different kinds are known sometimes by the different patterns and colours of which they are composed, but usually only by the names of the places where they are produced, such as Kaini, Meshedi, Baluchi, and Turshizi. The carpets of certain localities have always some distinction or superiority over those of other places, and the carpet industry is in a more flourishing condition in some localities than in others. Though carpets are woven all over Khorasan—not only in the towns and villages, but also in the tents of the nomad tribes—a large proportion are made for the use of the people themselves, and not for trade. At present carpets of fine quality are manufactured for trade in the two districts of Kain and Turshiz, but good carpets are also made in Meshed. For some ten years past traders have been in the habit of

giving instructions to weavers on the subject of carpets to be exported to foreign countries, and these carpets are said to realise better prices. In Kain the authorities and leading men are personally very fond of carpets, and as they themselves give instructions to the weavers, a very fine class with good patterns and colours is turned out. These are regarded as superior to the Meshed manufacture. All the different classes of carpets are made in varying sizes. Large ones measure up to 40 feet by $16\frac{2}{3}$ feet, and small ones from 5 feet by $2\frac{1}{2}$ feet up to $6\frac{2}{3}$ feet by $3\frac{1}{3}$ feet. A good quality of carpets, measuring 10 feet by $3\frac{1}{3}$ feet, and even smaller, are woven by the nomads, and especially by the Baluchis. All indigenous dyes used in the manufacture of carpets are obtained from vegetables. Aniline dyes imported from Europe were used formerly in Meshed, but were discontinued when it was found that the carpets containing them did not sell well. Carpets of inferior quality, made at Birgand, contain anilines, but those of better quality, which are made to order, do not. All parts of Khorasan, where carpets are made, produce wool, but in places such as Meshed, Turshiz, and Kain, where they are made for trade, a portion of the wool required is obtained from neighbouring districts. There is not much difference in the quality of the wool produced by the different districts of Khorasan, but that of the Baluch tribes is reckoned to be the best. The reasons given for that superiority are that most of their sheep are white, and that the Baluchis wash their wool better than any other tribes. Khorasan carpets are, however, not made entirely from wool. The woof is of wool, while the warp is of cotton. The pile is entirely of wool, because wool is more durable than any other material. In ancient times, silk was occasionally used for the pile, and even now, carpets can be made with a silk pile if specially ordered. The looms used for weaving carpets in towns are always put up indoors; those in the country sometimes indoors and sometimes out of doors. Carpets, however, of the better quality, even in the country, are usually made indoors, to save them from the dust. The weavers in the towns are always men and boys, those in the country, chiefly women. As far as is known, there is no difference in the methods pursued by the ancient and the modern weaver, and although old carpets are occasionally seen of a quality superior to that of any modern production, the art has not deteriorated.

CULTIVATION OF COCOA IN ECUADOR.

The preparation for planting the cocoa bean consists in clearing the land of all underbrush and trees by cutting and burning, which is commenced about July, and pushed on until the rainy season, beginning in November, December, and January. The United States Consul-General at Guayaquil, in his last report, says that after the ground has been cleared of all *débris*, it is marked in rows about five yards wide, and in each row sticks are driven about three yards apart, and at the foot of each stick a hole about three inches deep is made, into which are put three or four beans, over which is thrown sufficient earth to cover them. The next step is to plant rice, bananas, or other plants of rapid growth and shade, to protect the young cocoa plant from the sun's rays. It is usual to thus protect the plant for three or four years. The plant matures in six years, and begins bearing usually at four years, after which the only care necessary is to cut out the weeds twice a year, and this is the only cultivation ever given to the cocoa tree in Ecuador. An average of one thousand trees to the *cuadra* (about an acre and a quarter) are planted. The life of the tree is about one hundred years, the height about fifteen feet. The labourers to look after and attend to the trees, and to plant shrubs to shade the tree while young, usually have the privilege of living upon and cultivating the land free of rent; there is not, however, any fixed rule. If the owner personally supervises the work of the estate, the labourer is engaged by the day, month, or year; and the revenue from the cultivation of the land, the planting of cereals or plants to protect the young cocoa tree, belongs to the owner. The manner of gathering the cocoa is by cutting the pods from the tree with a large knife fastened to the end of a cane or pole. With these knives one set of labourers commence to cut off the pods; another follows, gathering and scooping them into piles; another cuts the pods open and scoops out the beans; and, finally, another follows with mules to carry the beans to an open, cleaned, and dry place, where they are dried by being spread in the sun for about six days. It is estimated that the total cost of gathering and preparing the cocoa for market does not exceed 12s. per 100 lbs. weight. After gathering and preparing, the bean is sent to Guayaquil, in bulk or in sacks, upon rafts, in canoes, or by steamer, where it is disposed of by the planter to an exporter or commission merchant. After reaching Guayaquil the bean undergoes further treatment. It is unloaded from the rafts, canoes, or steamers, and taken to the warehouses (*bodegas*), where it is cleaned by passing through a large sieve manipulated by two men. By this method the bean is cleared of the dust and dirt, leaving only the veins and hulls, which are picked out by hand, leaving, finally, the cleaned bean, which is spread in thin layers in the sun for five or six hours, when it is ready for packing and shipment. It is estimated that the loss in weight from handling, after arrival at Guayaquil, or final port of shipment, is about five per cent., which is chargeable to the purchaser abroad. In fact, every charge from the time the cocoa arrives at Guayaquil from the estate until it is placed on board the steamer for shipment, is charged to the foreign purchaser. All of the refuse from cleaning the cocoa, &c., the dust, hulls, and dried veins, has a market value, and

goes to swell the profits of the exporter or commission agent. The fine dust passing through the sieve is worth about 8s. per 100 lbs.; the hull, or *pelotas*, 16s.; and the veins, which are used for food for horses and mules, 4s. per 100 lbs. There are three grades of cocoa grown in Ecuador, as follows:—the *Arriba*, or first grade, is grown on the Guayas River and its tributaries above Guayaquil. This is the best grade, and represents about 65 per cent. of the whole crop, the main season for which extends from January to July. The *Balao*, or second grade, is grown below Guayaquil, in a district adjacent to Port Balao, from which this grade derives its name, and equals about 10 per cent. of the whole crop, the principal season for which is from July to December. The *Machala*, or third grade, is grown still further south, adjacent to the port of Machala, and equals about 15 per cent. of the whole crop, the principal season for which is the same as that of the second grade, *Balao*, from July to December. The cocoa district of Ecuador, as at present represented, embraces a radius of about 80 miles, with the city of Guayaquil as its base, though the best quality of cocoa and the greatest yield per tree appears to be in the northern part of the province of Esmeraldas, where no attention is given to its culture, but the life of the plant is said to be of short duration. While it is true that cocoa has its seasons, yet a little of each class is gathered and marketed outside their respective seasons, that gathered after the principal crop is called *Rebuscoz*, or gleanings, and is often as good, or better even, than that of the proper season. There are still one or two other classes, or grades, of cocoa grown in Ecuador. One known as the *Caraquez*, grown in the province of the port Bahia de Caraquez, on the coast north of Guayaquil, and the other is grown near the port of Esmeraldas, on the coast north of Bahai de Caraquez, and is superior to all other cocoas produced in Ecuador, though the production is insignificant. The two latter grades represent about 10 per cent. of the total. In round numbers there are 30,000,000 trees, and the annual production is from 28 to 30 million pounds of cocoa. The methods of cultivating the tree and of gathering and preparing the bean for market are difficult, tedious, and primitive, everything being done by hand and nothing by machinery. From the moment the pod is cut until the bean is put up into bags and shipped, the least possible time is lost. Consul-General Sorsby says in conclusion that everything is pushed on as rapidly as the habits and customs of the people admit, and that if a little more study and attention were devoted to the methods of cleaning and curing, the cocoa bean could be immensely improved in quality.

SUGAR PRODUCTION IN THE ARGENTINE REPUBLIC.

The growth of cane and the production of sugar in the Argentine Republic has of late years become quite an important industry, owing in a great measure to the facilities offered by the extension of railways for the conveyance of improved machinery for extracting the cane juice. Her Majesty's Consul at Buenos Ayres says that formerly mills with two wooden rollers, worked by bullocks or mules, were used, extracting not more than half the juice contained in the cane; now mills with three or more powerful iron cylinders or rollers are in use, extracting from 60 to 80 per cent. of juice, according as single or double crushing—as it is called—is resorted to. The fibre or *megass* forms from 10 to 12 per cent. of the total weight of the cane. In simple crushing three rollers are used, forming one mill, but on the more advanced estates, two of these mills are arranged tandem fashion, and the partially crushed cane of the first mill goes through the second, when a further extraction of juice takes place. At the same time the fibre or megass leaves the mill so much drier, or with so much juice less in it, that it is fit for direct consumption as fuel in the furnaces. Another method of extracting the juice than by the mill has recently been adopted, namely, the diffusion process, whereby the last drop of juice is taken from the cane. The diffusors are batteries of twelve or more tanks furnished with doors top and bottom, and connected one with the other by pipes for juice, water, and steam. Operations are begun by putting the canes into a slicing machine, which cuts the cane across into little chips of one-eighth of an inch thick; these chips are carried to the diffusors, and each is filled in succession. When the first is full, the top door is closed and hot water let in, which, in its downward passage through the chips, takes up much of its sweetness; it is passed into the second diffusor at the top, and again takes a downward course. In like fashion it goes on through all the tanks save two or three which are being emptied and refilled with chips. When the water, with its cargo of juice, has reached the tenth tank, a portion is drawn off, the rest made to flow to the eleventh, where another portion is withdrawn, and the remainder passing into the twelfth tank. In this manner the last drop of juice may be extracted from the cane. The other part of the process for converting the juice to sugar is similar to that followed where the mills are employed, except that defecation and clarification is conducted in the diffusors, and not in separate vessels. The province of Tucuman is the principal producer, but the provinces of Santiago del Estero, Salta, Corrientes, and Missiones add their quota. The canes are planted in rows, in large fields, and are carefully irrigated. The roots will last from ten to fifteen years without renewal. Each manufacturer grows a certain amount of cane, and also buys from surrounding farmers. The harvest commences about May or June, and continues until August and September. The cane must be crushed when freshly cut; and the yield varies from 80 to 100 tons per square of four and a quarter acres, according to dampness or dryness of the season and

age of the roots. The yield of juice is a varying quantity of from 70 to 85 per cent., and this again yields a varying quantity of sugar. One hundred tons of sugar may be expected to yield from six to seven per cent. of raw sugar in three grades under the centrifugal process.

Notes on Books.

Cooley's Cyclopædia of Practical Receipts, and Collateral Information in the Arts, Manufactures, Professions, and Trades, including Medicine, Pharmacy, Hygiene, and Domestic Economy, designed as a Comprehensive Supplement to the Pharmacopœia and General Book of Reference. Seventh edition, revised and greatly enlarged by W. North, M.A., F.C.S. London: J. and A. Churchill. 1892. 2 vols.

This is the seventh edition of a work originally published in 1856, and it has grown very considerably since it appeared in a single volume octavo. The scope of the work remains the same as heretofore, but the matter has been revised and amplified to bring it up to date. The article on Photography has been re-written and enlarged, and articles on Surveying and on Insects injurious to crops have been added. One of the most important divisions of the work has always been that of Pharmacy, and the articles in this class have been revised by Mr. A. W. Gerrard, Pharmacist to University College Hospital. Considerable alterations have been made in the articles referring to Veterinary Medicine, and in Domestic Medicine special revision has taken place, detailed accounts of many diseases and modes of treatment having been omitted in those cases where the supervision of a qualified medical practitioner appeared necessary. It is not necessary to give any detailed description of a work so well known as Cooley's Cyclopædia, but an indication of the wide field of subjects treated of in its pages may be obtained from a note of the titles of articles such as Alkali Acts, arsenical pigments, asphalte, oil paintings and the causes of their decay, photometry, printing, rain-gauge, ropes and knots. These few headings, although they can give the reader no true idea of the contents of the book, are sufficient to show how varied are the topics which are dealt with in it. These volumes are fully illustrated with figures of many of the objects, machines, and apparatus described in the articles.

Obituary.

Sir Richard Owen, K.C.B., F.R.S.—The renowned naturalist, who died in his 89th year, at Sheen-lodge, Richmond-park, on Sunday morning, 18th inst., was elected a member of the Society of Arts in 1855, and, in former years, he presided on several occasions at the meetings of the Society. He delivered one of the lectures on the results of the Great Exhibition of 1851, his subject being "The Raw Materials from the Animal Kingdom." In this *Journal* (Feb. 2, 1866) he replied to the remarks of Mr. Ayrton, at a meeting of the Society, on his supposed demand for a ten-acre building for the Natural History Collections. He asked for five acres, if the architecture of the building allowed of two stories, and stated that he wanted space, not for a "five acre museum," but for ground on which future extensions to the two and a half acre museum required for the collections might be made. The writer of the obituary notice in the *Times* points out that, in spite of the opposition to Prof. Owen's proposal, the space now placed at the disposal of the Superintendent of the Natural History Museum is one, not of five, but of over seven acres. The particulars of Sir Richard Owen's life are so well known, and have been so fully narrated in the newspapers, that it is not necessary to do more than set down here a few dates connected with his distinguished career. He was born at Lancaster, July 20, 1804. After studying at the grammar school of his native town, he matriculated at the University of Edinburgh in 1824; he became a member of the Royal College of Surgeons, London, in 1826; he succeeded his father-in-law, William Clift, as Conservator of the Hunterian Museum. This office he resigned in 1856, when he was appointed Superintendent of Natural History in the British Museum. In 1881, the new building for that department was opened, and, two years later, he retired from the position which he had filled for so many years. He was then created a Knight Commander of the Bath.

Dr. Soubeiran.—Dr. Jean Léon Soubeiran, the well-known pharmacist of Montpellier, died last week, and was buried in the cemetery of that city on Saturday, 17th inst., where his colleague at the University, Professor Gay, delivered a funeral oration. Professor Soubeiran was born at Paris on the 27th November, 1827. He became a licentiate in the natural sciences in 1853, and in the following year he obtained the diploma of a pharmacist of the first-class. He also took the degree of Doctor of Medicine, and that of Doctor of Science in 1858. His biological researches were divided between zoology and botany, and at the time of his death he was engaged upon a work on mineral waters. Dr. Soubeiran had been connected with the University of Montpellier for 20 years, and he was elected an honorary corresponding member of the Society of Arts in 1870.

Correction.—The following corrections are necessary in the report of Colonel Allan Cunningham's remarks on Prof. Forbes's paper, "Utilisation of Niagara":—Page 98, col. 2, line 8 from foot, *for* 280 cubic feet *read* 280,000; line 7 from foot, *for* one fortieth, *read* about 40 times; p. 99, col. 1, line 11, *for* 100 feet *read* 200 feet.

Journal of the Society of Arts.

No. 2,093. Vol. XLI.

FRIDAY, DECEMBER 30, 1892.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be given on Wednesday evenings, January 4 and 11, by R. Bowdler Sharpe, LL.D., on "The Curiosities of Bird Life."

The lectures will commence at seven o'clock. Members requiring tickets are requested to make early application for the few that still remain.

As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

STOCK PRIZE.

For the Decoration of Part of the Interior of a Building.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a Prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the annual competition held in 1893.

The prize is offered for the best original designs for an Architectural Decoration, to be carried out in any or all of the following processes, *e.g.*, painting, stucco, carving, mosaic, or any other process.

This Architectural Decoration is to be either for the side of a room, or a hall, a ceiling, or the apse or side of the chancel of a church, or any suitable part of the interior of a building.

The designs must be on imperial sheets. Each set must consist at least of a coloured drawing to scale of the whole design of decoration, and two coloured drawings of details on separate imperial sheets. Mere patterns or sketches of details, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The designs must have been made during the previous school year.

The designs are to be submitted, with other school work, in the usual manner, to the Department of Science and Art, in April, 1893. Each of the imperial sheets, forming a set of competing designs, must be marked, "In competition for the Stock Prize," *in addition* to being labelled or staged according to the regulations of the Department of Science and Art.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a Prize of £20 for competition amongst students of the Schools of Art of the United Kingdom, at the annual National Competition held in 1893.

The Prize is offered to the student who obtains the highest awards in the following subjects :—

(*a*) A finished drawing of imperial size from the nude living model.

(*b*) A set of time studies from the nude living model (mounted on imperial size mounts).

(*c*) A set of studies of hands and feet from the living model (mounted on imperial size mounts).

(*d*) Drawing from the life done at the examination on May 11th, 1893.

No student will be eligible for the award who does not pass in the examination *(d)* in drawing from the life, and who does not obtain an award for *(a)* the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The drawings, &c., are to be submitted, with other school works, in the usual manner to the Department of Science and Art, in April, 1893. Each competing drawing must be marked, "In competition for the Mulready Prize," *in addition* to being labelled according to the regulations of the Department of Science and Art.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d., on application to the Secretary.

Chicago Exhibition, 1893.

FINE ARTS COMMITTEE.

A meeting of the Committee on Fine Arts was held on 22nd inst. Present: Sir Fredk. Leighton, Bart., P.R.A., in the chair; J. Macvicar Anderson, P.R.Inst.B.A., Wyke Bayliss, P.R.Soc.B.A., Philip H. Calderon, R.A., W. E. Lockhart, H. Stacy Marks, R.A., W. W. Ouless, R.A., Edward J. Poynter, R.A., Marcus Stone, R.A., Sir Henry Trueman Wood, Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

Proceedings of the Society.

CANTOR LECTURES.

GENERATION OF LIGHT FROM COAL GAS.

By Vivian B. Lewes, F.I.C., F.C.S.,
Professor of Chemistry, Royal Naval College.

Lecture II.—Delivered November 28, 1892.

Leaving the brilliant work of Sir Humphry Davy and the lesser lights who followed in his wake, we come to the labours of another giant in our scientific world, one who is happily still with us, and whose work needs no posthumous halo to make it alike remarkable for its power, brilliancy, and the wideness of its scope.

Dr. Edward Frankland, whose researches were made first in the laboratories of Playfair, Bunsen, and Liebig, and afterwards at Queenwood, Owen's College, St. Bartholomew's, the Royal Institution, and the Royal College of Chemistry, has left, in the same way that Davy did, his stamp upon all he attempted. Whether working upon the isolation and identification of the radicles of which organic compounds are built up, and the evolution from them of new and unknown compounds, or employed upon the more practical investigations on water, sewage, and gas, with which his name is so closely identified, or in his studies on physical science, which served to make still pleasanter his vacations, Frankland threw into the researches his heart and soul, and has given us a record of work which is remarkable for the way in which he has not only disclosed to us new facts, but has attempted in every case to discover the principles underlying them.

In the August of 1859, Dr. Frankland, in company with Professor Tyndall, undertook an ascent of Mont Blanc, with the object of establishing thermometric stations between Chamouni and the summit of the mountain, and, at the same time, seized the opportunity of trying some experiments on the rates of the combustion of candles at high altitudes, in order to verify the accuracy of a statement made by Le Conte, that "the process of combustion is retarded by diminution of the density of the air, whilst it is accelerated by its condensation."

Burning six candles for one hour at Chamouni, Dr. Frankland carefully noted the loss of weight for each, and again repeated the experiment for one hour on the summit of Mont Blanc.

The average diminution in weight for each candle was 9·4 grams per hour when burnt at Chamouni and 9·2 when burned on the summit of the mountain; and the close agreement of these results, under such widely differing circumstances, naturally suggested to his mind that the rate of burning of substances which require the oxygen of the air to support their combustion is entirely independent of the density of the atmosphere.

Whilst watching the burning of the candles in the tent which had been erected on the summit of the mountain, Dr. Frankland was struck by the small amount of light which they emitted, and the way in which the non-luminous zone of the flame had extended its proportions to the detriment of the luminous zone.

Later on in the year, Dr. Frankland repeated these experiments under conditions which allowed of photometric measurement of the amount of light given by the candles under diminished pressure, and the results are best given in his own words :—

"The result proved that a great reduction in illuminating effect ensues when a candle is transferred from air at the ordinary atmospheric pressure to rarefied air. At the same time remarkable changes in appearance occur in the flame itself, especially at high degrees of rarefaction. During the diminution of pressure down to half an atmosphere, the chief alteration is the gradual invasion of the upper and luminous portion of the flame by the lower blue and non-luminous part. As the pressure sinks towards ten inches of mercury, the retreat of the luminous portion of the flame towards the apex goes on uninterruptedly, but the shape and colour of the flame also begin to undergo very remarkable alterations—the summit becomes more and more rounded until at ten inches pressure the flame assumes nearly the form of an ellipse, whilst the blue portion, which now comprises nearly the whole flame, acquires a peculiar greenish tint. Finally, at six inches pressure, the last trace of yellow disappears from the summit of the flame, leaving an almost perfect globe of the peculiar greenish-blue tint above mentioned. Just before the disappearance of the yellow portion of the flame, there comes into view a splendid halo of pinkish light, forming a shell half an inch thick around the blue-green nucleus, and thus greatly enlarging the dimensions of the visible flame. The colour of this luminous shell closely resembles that first noted by Gassiot in the stratified electrical discharge passing through a nearly vacuous tube containing a minute trace of nitrogen. The colour thus imparted to the electrical discharge undoubtedly constitutes the most delicate test of the presence of nitrogen. In both cases I believe the coloured light to be due to incandescent nitrogen."

"In attempting photometrical determinations with candles, it was found that, owing to the irregularities of combustion, no satisfactory quantitative experiments could be made in artificially rarefied air. Oil-lamps also proved equally unsuitable, owing to the gradual ascent of the base of the flame towards the apex of the wick, by which the size of the flame and the hourly consumption of the oil were greatly diminished. Recourse was therefore made to coal gas, which, although liable to certain minor disturbing influences, yet yielded results, during an extensive series of experiments, exhibiting sufficient uniformity to render them worthy of confidence."

From the results of these experiments Dr. Frankland deduced the following important law:—

"Of 100 units of light emittted by a gas flame burning in air at a pressure of 30 inches of mercury, 5·1 units are extinguished by each diminution of one mercurial inch of atmospheric pressure, or, more generally, the diminution in illuminating power is directly proportional to the diminution in atmospheric pressure."

As a natural sequence to these experiments he made a second series upon the effects of compressed air upon the luminosity of similar flames.

"At the very outset of this part of the inquiry, considerable difficulties presented themselves, since it became necessary to abandon a gaseous combustible, which could not be compressed to the necessary degree, and then delivered at a uniform pressure through a burner without very complex apparatus. I was thus compelled to resort to solid or liquid combustibles, the irregularities of which where still further increased by the space within the combustion chamber being necessarily more confined, in order that its walls might the better sustain high pressures. These difficulties in the way of accurate determinations, however, were by no means the most formidable, for it was soon found that any considerable increase of atmospheric pressure caused both candle- and oil-flames to throw off large quantities of fuliginous matter, the formation of which could not be prevented by any amount of draught that could be established in the chimney of the apparatus. Hence, although the luminosity of the flames was greatly increased, yet it was obviously much less so than would have been the case under conditions o more perfect combustion. In fact, it soon became evident that the determinatinn of increase of luminosity by compression must be made in a manner precisely the reverse of that employed for the corresponding determinations in rarefied air, for, whilst in the latter case the experiments were made with flames, which, at ordinary atmospheric pressure, were saturated with luminous matter, in the former it was found necessary to commence with flames which were very feebly, or not at all, luminous at common pressures. Such is the effect of compressed air in determining the precipitation of carbon particles within the flame, that a small alcohol lamp which at the ordinary pressure burnt with a pure blue flame, became highly luminous when placed under a pressure of four atmospheres, and it can scarcely be doubted that, at a pressure of five or six atmospheres, its luminosity would be equal to that of sperm oil burning at atmospheric pressure.

"Owing to these difficulties, I have only been able to obtain satisfactory determinations between one and two atmospheres. In these determinations the lamp was supplied with amylic alcohol, a liquid which, whilst affording an appreciable amount of light in the experimental flame under one atmospheric pressure, was found to burn under two atmospheres without smoke, although at a somewhat higher pressure it began to evolve fuliginous matter."

The results of the experiments approximate to those calculated from the law given for pressures less than that of the atmosphere, but when continued to still higher pressures, results were obtained which differed very widely from those one would have expected.

In discussing the probable causes of these

and other slight variations from the law, Dr. Frankland says :—

"The luminosity of the flames generally used for artificial light emanates from two sources, viz., first from the ignition of minute particles of carbon floating in the shell of the flame, and, secondly, from the incandescence of gaseous matters. The latter source of illumination probably does not furnish more than 1 per cent. of the total amount of light, consequently nearly the whole of the light given out by flames under ordinary circumstances is due, as Davy first pointed out, to the ignition of solid carbonaceous matter."

This shows that at this time (1861) his views on the cause of luminosity in flame were in accord with Davy's, and he finally sums up the influence of atmospheric pressure upon the combustion as follows :—

"1. The rate of burning of candles and other similar combustibles, whose flame depends upon the volatilisation and ignition of combustible matter in contact with atmospheric air, is not perceptibly affected by the pressure of the supporting medium.

2. "The luminosity of ordinary flames depends upon the pressure of the supporting medium, and, between certain limits, the diminution in illuminating power is directly proportional to the diminution in atmospheric pressure.

3. "The variation in the illuminating power of flame by alterations in the pressure of the supporting medium depends chiefly, if not entirely, upon the ready access of atmospheric oxygen to, or its comparative exclusion from, the interior of the flame.

4. "Down to a certain limit, the more rarefied the atmosphere in which flame burns, the more perfect is the combustion."

It was in the June of 1861 that Frankland contributed these important observations to the Royal Society, and seven years later he published a still more important communication in their "Proceedings"—a paper in which he shows that flames like those of hydrogen or carbon monoxide in oxygen, which cannot possibly contain solid matter, yet can be made to emit light when burning under sufficiently high pressure. In this paper, which was read on June 11, 1868, he says :—

"Further experiments, made more than a year ago, on the nature of the luminous agent in a coal-gas flame, led me to doubt the correctness of the commonly received theory first propounded by Sir Humphry Davy, that the light of a gas flame, and of luminous flames in general, is due to the presence of solid particles. In reference to gas and candle-flames, it is now well known that the fuliginous matter produced when a piece of wire-gauze is depressed upon such flames, and the sooty deposit which coats a piece of white porcelain placed in a similar position, are not pure carbon, but contain hydrogen, which is only completely got rid of by prolonged exposure to a white heat in an atmosphere of chlorine. On pursuing the subject further, I found that there are many flames possessing a high degree of luminosity which cannot possibly contain solid particles. Thus the flame of metal arsenic burning in oxygen emits a remarkably intense white light, and as metal arsenic volatilises at 180°C., and its product of combustion — arsenious anhydride —at 218°C., whilst the temperature of incandescence of solids is at least 500°C., it is obviously impossible here to assume the presence of ignited solid particles in the flame. Again, if carbonic disulphide vapour be made to burn in oxygen, or oxygen in carbonic disulphide vapour, an almost insupportably brilliant light is the result. Now fuliginous matter is never present in any part of this flame, and the boiling point of sulphur, 440°C., is below the temperature of incandescence, so that the assumption of solid particles in the flame is here also inadmissible. If the last experiment be varied by the substitution of nitric oxide gas for oxygen, the result is still the same, and the dazzling light produced by the combustion of these compounds is also so rich in the more refrangible rays, that it has been employed in taking instantaneous photographs, and for exhibiting the phenomena of fluorescence.

"Many other cases of the production of brilliant light from incandescent, gaseous, or vapourous matter might be cited, but I will mention only one other. Amongst the chemical reactions celebrated for the production of dazzling light, there are few which surpass the active combustion of phosphorus in oxygen. Now, phosphoric anhydride, the product of this combustion, is volatile at a red heat, and it is therefore manifestly impossible that this substance should exist in the solid form at the temperature of the phosphorus-flame, which far transcends the melting point of platinum. For these reasons, I consider that incandescent particles of carbon are not the source of light in gas- and candle-flame, but that the luminosity of these flames is due to radiations from dense but transparent hydrocarbon vapours.

"As a further generalisation from the experiment above mentioned, I was led to the conclusion that dense gases and vapours become luminous at much lower temperatures than aeriform fluids of comparatively low specific gravity, and that this result is, to a great extent, if not altogether, independent of the nature of the gas or vapour, inasmuch as I found that gases of low density, which are not luminous at a given temperature when burnt under common atmospheric pressure, become so when they are simultaneously compressed. Thus, mixtures of hydrogen and carbonic oxide with oxygen, emit but little light when they are burnt or exploded in free air, but exhibit intense luminosity when exploded in closed glass vessels, so as to prevent their expansion at the moment of combustion.

"I have recently extended these experiments to the combustion of jets of hydrogen and carbonic

oxide in oxygen under a pressure gradually increasing to twenty atmospheres. These experiments were conducted in a strong iron vessel, furnished with a thick plate of glass of sufficient size to permit of the optical examination of the flame. The results are so remarkable that, although still far from being complete, I venture to communicate them to the Royal Society before the close of the session. The appearance of a jet of hydrogen burning in oxygen under the ordinary atmospheric pressure is too well known to need description. On increasing the pressure to two atmospheres, the previously feeble luminosity is very visibly augmented, whilst at ten atmospheres' pressure the light emitted by a jet about one inch long is amply sufficient to enable the observer to read a newspaper at a distance of two feet from the flame, and this without any reflecting surface behind the flame. Examined by the spectroscope, the spectrum of this flame is bright and perfectly continuous from red to violet.

"With a higher initial luminosity the flame of carbonic oxide in oxygen becomes much more luminous at a pressure of ten atmospheres than a flame of hydrogen of the same size and burning under the same pressure. The spectrum of carbonic oxide burning in air is well known to be continuous; burnt in oxygen under a pressure of fourteen atmospheres, the spectrum of the flame is very brilliant and perfectly continuous."

This paper, striking as it did at the root of the fundamental ideas existing as to the causes of luminosity in flame, caused a profound sensation, and it was not long before the interest taken in it was made manifest by criticisms and attacks upon the new theory put forward.

One of the first of these was by W. Stein ("Journal für pract. Chemie," 2, viii. 401), who, in criticising the various points in Frankland's paper with regard to the observation that the soot deposited from a luminons flame is not pure carbon but contains hydrogen, points out that:—

"The first objection to this is that, as is well known, not only do all heavy hydrocarbons decompose with deposition of carbon at a high temperature in absence of air, but even marsh gas itself does so. Since now the hydrocarbons, whose vapours are supposed to produce the luminosity, are under such conditions before they are reached by the oxygen of the air, it cannot be doubted that they must under a decomposition in the luminous part of flames into carbon and hydrogen. Whether the separated carbon is chemically pure, or whether it is mixed with a body containing hydrogen, is of slight importance, since the chief question with which we are concerned is whether the soot is present in the flame as vapour or in the solid state. If it were a conglomeration of the densest light-producing hydrocarbons, whose vapours condense on the cold body, then it must, when strongly enough heated in absence of air, again be vapourised. This, however, is not the case as every one will find who tries the experiment. Moreover, its chemical composition is just as little favourable to Frankland's view. This will presumably vary according to the different luminous material from which the soot is obtained, and also according to the position in the flame from which it is taken. For the temperature of flame is, as is well known, different at different points, and as known from the researches of Magnus, at lower temperatures, in addition to carbon, a tarry product containing hydrogen, separates from the hydrocarbon. The soot, of which I give an analysis below, was collected from a gas-flame by sinking the bottom of a small silver kettle filled with water, 2 to 3 mm. deep into the flame. Benzine extracted from it traces of a solid yellow body, which, on account of its small quantity, could not be further examined. Nothing was extracted by alcohol, alcoholic potash, and dilute sulphuric acid. After careful and continued washing with boiling water and drying at 130°, 0·206 gave 0·6985 carbonic acid, 0·0195 water, 0·0020 ash. This amounts to:—

		Or on ash free substance
Carbon ..	96·446 per cent. ..	97·390 per cent.
Hydrogen.	1·051 ,, ..	1·061 ,,
Ash......	0·970 ,, ..	— ,,
Oxygen ..	1·533 ,, ..	1·549 ,,

The oxygen which it contains must, I think, be ascribed to a small quantity of water being left in it even after drying at 130°. If this be deducted, then the water and ash free substance consists of 99·905 carbon and 0·905 hydrogen. This analysis consequently confirms that view of the chemical composition of the soot of flames, which is based on the known behaviour of hydrocarbons at high temperatures."

And, again:—

"In order to show that his view of the luminosity of vapour is not without examples, Frankland points to the luminosity which takes place on burning arsenic, phosphorus and carbon bisulphide in oxygen gas at the ordinary pressure, and hydrogen and carbonic oxide at an increased pressure, since in these cases the co-operation of solid particles cannot come in question. However valuable and interesting this all may be from a scientific point of view, it does not in any way prove that the process in our luminous flames must be an analogous one, since the well-established fact that solid bodies are specially adapted for becoming radiant is not altered by it, and up to the present only one solid body has been discovered to which one could ascribe the luminosity of these flames. When, therefore, all that has been stated is considered, no other conclusion can be arrived at but that the light of our luminous flames comes from in-

candescent particles of carbon, and that therefore the old view is the true one."

About this time Knapp showed that the luminosity of a coal-gas flame could be destroyed not only by admitting air, as in the Bunsen burner—which up to this time had been supposed to destroy luminosity by the more rapid combustion of the carbon particles—but also by burning the coal gas with inert gases, such as nitrogen and carbon dioxide, which could take no part in the combustion, a phenomenon explained by Wibel as being due to the cooling effect of these gases upon the flame, as luminosity may be restored by heating the mixture of gases just before combustion.

These views were criticised by Dr. Karl Heumann in "Liebig's Annalen," vols. clxxi. and clxxx., as well as Frankland's work, concerning which he says :—

"Frankland has broached the hypothesis that the luminosity of flame is not due to particles of suspended carbon, but is caused by the vapours of heavy hydrocarbons which radiate white light. Strong positive evidence in support of a view so much at variance with the generally accepted theory, could hardly be expected, and Frankland has relied principally upon the fact that we are acquainted with many luminous flames in which we cannot suppose that solid matter is present.

"To the instances already known Frankland has added the interesting observation that hydrogen and carbon monoxide when burned in oxygen under a pressure of 10 to 20 atmospheres, yield a luminous flame affording a continuous spectrum, and also that the faintly luminous flame of alcohol becomes as bright as that of a candle when the pressure is increased to 18 or 20 atmospheres. These experiments are not so convincing as might at first sight appear, inasmuch as we know that the temperature of the flame is increased at high pressures, and also at the temperature of the electric spark many gases yield a continuous in place of a line spectrum. The power of gases as regards emission of light also varies considerably under these circumstances, and it does not appear that we are absolutely necessitated, as Frankland has supposed, to ascribe the increase in luminosity to the increased density of the gas, although doubtless this circumstance is not without considerable influence.

"The inquiry as to the nature of hydrocarbon flames is quite independent of the meaning which we may attach to these appearances, and if Frankland puts forward the above cited phenomena of combustion as analogies to guide him in views concerning carbon-flames, no very forcible argument can be really deduced from the examples, because, as W. Stein has pointed out, it cannot be shown that the reaction in luminous carbonaceous flames must be an analogous one to that described above.

"Frankland's declaration that the soot must be regarded as an accumulation of heavy hydrocarbons, whose vapours are condensed on the cold body brought into the flame, may be regarded as almost confuted by Stein's objection, that in this case the soot must become gaseous at higher temperatures, which is not the case."

And then going on to Wibel's conclusions points out that :—

"Everyday experience tells us that the blue flame of Bunsen's burner, as well as that of the blow-pipe, possesses a much higher temperature than the ordinary luminous flame; but if Wibel be correct in saying that decrease in luminosity is a consequence of cooling only, then, logically, the temperature of the luminous flame ought to be higher than that of the non-luminous flame."

He then attacks the various problems which the Bunsen flame gives rise to, and finally concludes that—

"When air destroys the luminosity of a coal-gas flame, there are at least three causes, each of which is capable of decreasing the luminosity of these flames, viz., withdrawal of heat, dilution, and oxidation of the luminous material.

"In most cases two or more of these causes are at work: in non-luminosity brought about by nitrogen and carbon dioxide, especially dilution and heat absorbtion; in the widening out of a flame caused by a cold surface absorbtion of the heat, and a more rapid oxidation of the carbon; and in non-luminosity caused by air each of the three causes is at work.

"The flame of a Bunsen's burner appears to be the final product of a whole series of causes acting some in one direction, some in another, and it is not to be wondered at that observers of luminous flames have arrived at such diverse and contradictory conclusions, inasmuch as they have made the study of this flame their principal object, overlooking the great complexity of the conditions affecting it, instead of preceding such a study by an investigation of more simple instances of combustion."

He then fully discusses the effect of cooling upon the combustion in flames, and comes to the following important conclusions :—

"1. The fact that a gas-flame does not rest upon the burner nor a candle-flame upon the wick, as also the fact that a flame never directly touches a cold body held within it, is to be explained by the cooling action exercised upon the gas by its surroundings.

"When the combustible gases are cooled throughout a definite space below their ignition-temperature, the flame is extinguished.

"2. The very considerable distance noticed between the burner and the flame of a gas issuing under high pressure, or mixed with a large volume of an indifferent gas, is to be traced to the cooling

action of the stream of gas and of the outer air, and perhaps more especially to the fact that the velocity of propagation of ignition within the gas."

In a second paper, published in the "Annalen," clxxxiii., "On the influence of withdrawal from, and addition of heat to, luminous flames," several interesting points are discussed, and the author finally points out that—

"A cold object brought into a luminous flare causes a suspension of the process of combustion in its immediate neighbourhood, and, at the same time, very materially diminishes the luminosity throughout a considerable space around itself.

"Carbon-containing luminous materials may burn with or without separation of carbon—that is, with or without luminous flames—according as a certain temperature, differing for each material, is or is not maintained. Combustible material which has been diluted with indifferent gases requires to be maintained at a higher temperature, in order that it shall burn with a luminous flame, than when it is not so diluted.

"The fact that soot is deposited on a cold object held in a luminous flame is no proof of decreased temperature within the flame, inasmuch as it has been shown that decreased temperature causes a diminution in the quantity, or even total suppression of the separated carbon.

"Soot is also deposited on heated surfaces, but is quickly burned on admission of air. Inasmuch as admission of air cannot be altogether prevented, less soot is accumulated on hot than on cold objects.

"Burners constructed of iron or other material possessed of high conductivity for heat, cause a greater diminution in the luminosity of the lower part of the flame than burners of steatite. The difference between the luminosities of the two flames is rendered more apparent by artificially cooling the burner.

"The top of the burner and the entering cold gas both exert a cooling action upon the lower part of the flame, and are the cause of the space noticeable between the burner and the flame-mantle. By heating the burner and simultaneously the stream of gas, a more luminous flame is obtained without an increased consumption of gas, the increase in luminosity being greater the smaller is the consumption of gas.

"The change which is hereby caused in the chemical composition of the gas is without appreciable effect upon the luminosity, inasmuch as no diminution in luminosity is occasioned by again cooling the stream of gas.

"The heat communicated by increasing the temperature of the burner-tube acts in two ways; it increases the intensity of the light of the flame-mantle, and simultaneously enlarges the flame itself. Carbon is also sooner separated in the flame, and separated at a higher temperature."

His most valuable contribution to the question of whether luminous hydrocarbon flames contain solid particles or not, is to be found in volume clxxxiv. of the "Annalen," in which he shows that—

"1. Chlorine causes an increase in the luminosity of feebly-luminous, or non-luminous hydrocarbon flames. Inasmuch as chlorine decomposes hydrocarbons at a red heat, with separation of carbon, it follows that the increased luminosity is due to the production of solid carbon particles.

"2. A small rod held in the luminous flame becomes rapidly covered on its lower surface—the surface exposed to the issuing gas—with a deposit of soot. The solid soot is evidently driven against the rod. If the soot were present as vapour in the luminous flame, its deposition would be due to a lowering of the flame-temperature, and would therefore take place on all sides of the rod.

"3. A strongly heated surface also becomes covered with a deposit of soot. This would not be possible if the deposit were the result of the cooling action of the surface upon the flame.

"4. The carbon particles present in the luminous flame become visible when the flame is caused to rush against another flame, or against a heated surface. The separated particles are rolled together into larger masses, so that the luminous mantle becomes filled with numerous glowing points. The soot of such a flame is very coarse-grained.

"5. The luminous mantle of a flame is not altogether transparent, the thicker the flame-layer, and the greater the number of solid particles contained therein, the less transparent does it become. The transparency of a luminous flame is no greater than that of the—approximately—equally thick stratum of soot which rises from the flame of burning turpentine, and which is universally allowed to contain many solid particles. A luminous flame of hydrogen, containing solid chromic oxide, is as transparent as the hydrocarbon flame.

"6. Those flames which undoubtedly owe their luminosity to the presence of finely divided solid matter produce characteristic shadows when viewed in sunlight. The only luminous flames which do not produce true shadows are those which consist of glowing vapours and gases. Luminous hydrocarbons produce strongly marked shadows in sunlight, these flames, therefore, contain finely divided solid matter. That this solid matter can be nothing but carbon, is evident from the fact that other substances, capable of remaining solid at the temperature of these flames, are absent.

"These proofs are, I think, sufficient to convince everyone that the luminous flames of the hydrocarbons actually contain solid carbon particles."

This splendid contribution to the carbon particle theory of luminosity in hydrocarbon flames, was further strengthened by researches made by Soret ("Philosophical Magazine,"

1875), who showed the existence of solid particles in a luminous hydrocarbon flame, by focussing the sun's rays upon the luminous portion of the flame, and examining the light reflected by it by the aid of a Nicol's prism. Burch also, in 1885, did the same thing in a very similar way. Whilst demonstrating to his landlady that the sun's rays did not extinguish the fire, but only prevented the light emitted by the glowing embers being seen, he was struck by the power of the sunlight in overcoming the light emitted by even highly incandescent bodies; and found that on focussing the sun's rays on a flame a spot of light was visible on the highly luminous mantle of the flame, and the reflected light from this gave ample evidence, when examined by the spectroscope, of the presence of solid particles. Quite lately, also, Sir George Stokes has come to the same conclusion, by experiments of the same character.

I have this evening brought before you the one celebrated attack upon Davy's theory, and the further evidence which it brought forth; and I confess that to my mind the facts are so overwhelmingly in favour of Sir Humphry's original assumption as to the cause of luminosity in hydrocarbon flames, that although Dr. Frankland undoubtedly showed that solid matter was not a necessity for a luminous flame, yet we must admit that in the special class of flames we are considering, the light-giving power is practically entirely dependent on their presence. It must, however, be borne in mind that Dr. Frankland himself is in no way shaken in his opinion, and we may all hope to hear further proof of his theory.

Whilst the physical aspects of luminosity were being studied in this way, there had not been wanting attempts to attack the question from a chemical point of view, and the researches of Dr. Hilgard, Landolt, and Blochmann have done much towards enlightening us as to the chemical changes taking place in hydrocarbon flames; but as the facts demonstrated by their work fit in best with the theories I shall have to bring before you next week, a discussion of their results will be better reserved until then.

Miscellaneous.

MINERAL WEALTH OF LOWER BURMAH.

The gradual development of the tin industry in the Straits Settlements, principally on the eastern coast of the Malay Peninsula, as well as the satisfactory results obtained by speculators, cannot fail to attract the attention of the public to the mineral deposits of Lower Burmah.

The *Bulletin du Musée Commercial* quotes a report from the Belgian representative at Calcutta to the effect that, in order to meet the numerous demands of the public of India and Straits Settlements, the Government of India decided to send the head of the Indian Geological Department, Mr. Hughes, to explore the districts of Merguy and Tavoy, in the province of Tenasserim.

The report of this specialist contains, on the one hand, his views as to the different tin and auriferons deposits, the existence of which has been known for a long time, and on the other hand, his observations as to the discovery of coal; these deposits have been subjected by him to a minute examination.

As regards gold, Mr. Hughes says that only a very small quantity has been discovered. The expert called upon to examine the district of Tenasserim has arrived at the same conclusion as his predecessors, namely, that the only gold discoverable was the worked gold.

On the right bank of the river of Grand Tenasserim he discovered a fine deposit of gold, but this deposit is situated beneath a pagoda. It is said that the ancient kings of Tenasserim monopolised the manufacture of articles of gold. This would explain the discovery of numerous jewels of gold found in the ground at present occupied by the police-station, and on which the king's palace originally stood. If what is stated is true, gold must certainly have existed in Tenasserim in considerable quantity.

The deposits of tin are of a sufficient extent, and of such easy access, as to give a remunerative yield, provided they are properly worked. Hitherto this possibility has been doubted. It is certain that the deposits of tin are spread over a considerable area, and, there is every reason to believe—according to the geological aspect of the peninsula—that, as the virgin soil is worked, new deposits will be met with north and south of the region already explored.

But few new deposits have, says Mr. Hughes, been discovered in the course of the year. One of his assistants has found a deposit of tin, which could scarcely be worked with profit, seeing the present price of the article; but he has pointed out a few which could be worked, if the prices of tin reascended to the level reached five or six years ago.

The existence of coal in this region, says Mr. Hughes, has been known for a long time. Dr. Oldham, in a report published in 1856, alluded to the coal mines of Tenasserim, and, in 1842, the coal formed the subject of an analysis which differed but little from that of the present day, an interval of 50 years. This fact is a remarkable example of the time which may elapse between the discovery of a mine and its putting into working, for these mines may still be considered as virgin. Mr. Hughes's assistant sank two shafts to a small depth, and succeeded in

obtaining coal of a very good quality in considerable quantity. This combustible contains a large proportion of water, but it is excellent compared with the different kinds of coals commonly used in India.

Trials of this coal have been made in a steamer, and no difficulty was experienced in propelling it, even with native firemen, by keeping a sufficient pressure for a long distance. The coal which was used had been exposed to the rain for two months, and to the flow of the sea for a fortnight, before being used.

Mr. Hughes estimates at a million tons the capacity of this mine. It is calculated that the coal will cost about 10s. per ton at the pit's mouth at Mergui. This price is undoubtedly a little high, but it may be considered as a maximum.

The good quality of the coal being granted, the Government geologist is convinced that the workers will make a profit of at least two rupees per ton. A million tons will therefore give a net profit of two million rupees. But a better market than Mergui will be wanted. There are two, Rangoon and Penang, where it may be sold in large quantities. Unfortunately Mergui is not accessible to steamers, and only small and shallow vessels can anchor there.

If this coal should become in demand, special lighters will have to be constructed for its carriage. The cost of carriage from the mine to the port of Mergui will probably be 2 rupees per ton, but if the abundance of the combustible requires the construction of small boats, 1 rupee 8 annas will be sufficient to pay these expenses of carriage. It may be thought that a steam tramway from the mine to the port of shipment might be economical. The conformation of the country does not render the establishment of a railway impracticable, but a large output would be necessary to pay the interest on the capital required for such an enterprise.

Another solution remains, that sooner or later a railway between Burmah and the Malay Peninsula may be established; this line would solve the problem of the access to the mines of Tenasserim.

Mr. Hughes' opinion of the coal of Tenasserim is that it is excellent and abundant, and that the cost of carriage from the mine to the sea will not exceed 7 rupees 12 annas per ton.—*Board of Trade Journal.*

TRADE WITH JAPAN.

In 1862, Great Britain only shipped to Japan goods to a very small extent; but from 1865 to 1875, the exports of British produce and manufactures to Japan averaged about £1,500,000. In the next five years it averaged £2,500,000, reaching £3,291,000 in 1880; then it fell back a little to about £2,200,000, but in the last three years it has averaged nearly £4.000,000. Our imports from there are but small, seldom having reached £600,000, but in the last three years these have increased to over £1,000,000 sterling a year.

Our export trade has doubled in the last five years, the value being a little over £2,000,000 in 1886, and £4,081,793 in 1890; last year it was £1,000,000 less.

The general foreign trade of the empire is also progressive, as is shown by the following figures of the values:—

	Imports.		Exports.
1875....	£4,245,000	......	£3,743,000
1885....	6,110,000	......	7,529,000
1889....	10,113,000	......	10,413,000

The exports of tea still increase, having been from 1882 to 1884 about 23,500,000 catties; in 1885, 27,000,000 catties; and in 1890, 37,250,000 catties. About 5,000,000 catties of camphor are shipped annually, but silk has dropped from 4,000,000 catties to 3,000,000 in 1890. Of coals, they used to import 4,000 to 5,000 tons, but now they are able to export over 1,000,000 tons. Blankets and other woollens are imported to the value of nearly £1,400,000, and cotton manufactures to the value of £500,000, although the Japanese grow cotton and manufacture it largely themselves.

THE LIME-JUICE INDUSTRY.

The United States Vice-Consul at Antigua says that the date of the introduction of the lime tree into the Leeward Islands is a matter of conjecture. So far back as 1791, it is recorded that large quantities of the fruit of this tree were exported from Dominica to England and America. It was not, however, until 1850 that the systematic cultivation of the tree began in Dominica. In Montserrat the industry is carried on in a more systematic manner than in any of the other islands of the group, and at the present time Montserrat is the chief seat of the lime industry of the Leeward Islands. There is a considerable quantity of lime-juice manufactured in Dominica, but there the orchards are smaller, and, with one or two exceptions, the same care is not exercised in the cultivation of the trees nor in the manufacture of the juice. In St. Christopher and in Antigua the cultivation of the lime is unknown, and neither of these islands manufacture lime-juice for export. The trees are raised from seed in nurseries, and transplanted when ten to eighteen inches high to the orchard, where they are planted in rows about fifteen feet apart, each acre requiring from 175 to 200 plants, light, sandy loam soil being best suited to their vigorous growth. In Dominica, where the soil is rich, the lime tree attains its greatest height, and yields the most fruit, a large juicy lime which is very rich in citric acid. A lime tree will grow in almost any soil, but the fruit is small, and the life of the tree is not so long as in rich, well-cultivated lands. From three to four years from the time of trans-

planting, the tree begins to bear fruit, and it continues to bear for over twenty years. The largest crops are gathered in years in which the rainfall is heaviest. The average yield of fruit from an orchard in full bearing would be about sixty to eighty barrels from an acre per annum. A barrel of fruit will yield from six to seven gallons of juice, and each gallon of sound, ripe juice contains from twelve to fifteen ounces of citric acid. The produce exported from a lime plantation is as follows:—Raw and concentrated lime-juice, green and pickled limes, and essential oil. Raw lime-juice is simply the juice from good, sound, ripe fruit, carefully preserved in casks. For the best quality the limes are crushed between the rollers of a mill. Old cane mills are usually employed for the purpose. The first two rollers are carefully adjusted to admit the limes, the second and third usually extract all the juice, which is then run into casks and is ready to ship. In the manufacture of concentrated lime-juice, the crushing is done in the same manner as for raw lime-juice. The fruit for concentration is, however, not selected as for raw lime-juice. On plantations where raw lime-juice is manufactured, the fruit which is unfit for manufacturing into raw lime-juice is crushed and turned into concentrated lime-juice. This process consists in boiling the juice in open pans, until it is reduced to from six-eighths to one-tenth of its volume, it is then a black viscid fluid, containing from 10 to a 100 ounces of citric acid per gallon. When the juice has been concentrated to the desired strength, it is run into casks, and shipped principally to the New York market. The export trade in green limes is very small, and is not increasing; the small quantity which is shipped goes to the English market. The fruit is carefully selected, picked from the trees, wrapped in paper as is usually done with oranges, packed carefully in crates and shipped. Another form in which the fruit is exported consists in selecting good sound ripe limes and placing them in casks, over which is poured salt water or strong brine. The cask is then made perfectly air-tight, and shipped to Boston. Essential oil, another valuable product obtained from the lime, is made largely in Montserrat and Dominica. There are two kinds of essential oil of limes, the hand-made, which is the most valuable; the other, an oil procured by distillation. The hand-made oil commands a much better price, as its perfume is not affected by the heat necessary in distillation. The common mode adopted of extracting this oil from the limes consists of the use of a shallow concave metal plate, shaped like an ordinary saucer, in which are studded a number of blunt copper spikes, from the centre of which there is a tube in which the oil runs as it escapes from the rind of the lime. The tube serves as a handle, and the lime is gently and quickly rolled over the blunt copper spikes until the oil escapes and runs into the tube. When the tube is full, the oil is poured into bottles and securely corked. Women are generally employed at this work, and they select only the finest fruit, which yields the greatest quantity of oil. The limes so used are then put through the mill for the manufacture of lime-juice. When the bottle is full it is allowed to stand for some time until the water and other impurities settle. The oil is then carefully drawn off and filtered as it is run into tinned copper vessels ready for export. Most of the oil exported from Dominica is manufactured by distillation from the lime-juice which leaves the mill. It is chiefly employed in scenting soaps and in the manufacture of common essences and perfumes.

THE CALORIFIC VALUE OF FUELS.

The Council of the French Société d'Encouragement de l'Industrie Nationale, acting on the proposition of its Chemical Arts Committee, and after discussing a report by M. Hirsch, decided to take the initiative in experimental research with the object of determining certain specific constants of substances the exact knowledge of which is becoming more and more important in many industrial operations. Accordingly, a sum of 3,000 fr. (£120) was placed to the credit of the Chemical Arts Committee for prosecuting independent calorimetric investigations into the fuels employed in industry. With the use of the laboratory of the Paris School of Mines, M. P. Mahler undertook the task, and is reported by M. A. Carnot and M. H. Le Chatelier, in the name of the Chemical Arts Committee, to have more than carried out the programme traced, having not only studied coal and the liquid or gaseous fuels derived from it, but also extended his researches to various other combustible substances, such as lignite, peat, wood, vegetable oils, and petroleum. In the course of his labours M. Mahler also devised a modification of the Berthelot and Vieille calorimetric bomb, which permits of determining, practically and very correctly, the calorific value of all classes of fuel.

M. Mahler begins the report of his work by describing the elementary analysis of fuel, which is a purely chemical operation, and then proceeds to set forth the direct determination of solid, liquid, and gaseous fluids by a simple method within the reach of all manufacturers; but he observes that no trustworthy determination was made before the appearance of thermo-chemical theories and the Faber and Silbermann calorimeter, which led to the researches of M. Scheurer-Kestner and M. Meunier-Dolfus.

The sample of fuel to be tested is introduced into the Mahler shell, which is a strong and close chamber, and afterwards oxygen under pressure, when the whole apparatus is immersed in the water of the calorimeter. If the fuel be then ignited, it will burn completely and almost instantaneously, the water formed by the combustion of

the hydrogen being condensed on the inside surface of the bomb. The heat disengaged by the explosion is transmitted, without any loss whatever, to the water of the calorimeter, and may easily be estimated, while, on account of the rapidity of the operation, most of the usual corrections, such as those relating to the evaporation of the water and variations of the surrounding temperature, may be neglected. The pressure of oxygen is determined by the condition that combustion be always complete; and an excess of oxygen is indispensable.

The apparatus consists essentially of a shell, forged out of high-class mild steel, having a capacity of 654 cubic centimetres (say 40 cu. in.), and weighing about 4 kilogrammes (or $8\frac{4}{5}$ lbs.) with its accessories. The shell, which is 8 millimetres ($\frac{5}{16}$ inch) thick, is nickelised on the outside, and enamelled inside, so as to withstand the corrosive and oxidising action of combustion; but the coating of enamel is not thick enough to interfere with the transmission of heat. The shell is closed by a screw plug, tightened on to a lead ring; and the plug is provided with a conical screw cock, for the introduction of oxygen. A platinum rod, attached to the plug, holds the capsule, on which is placed the fuel to be tested; and the latter is ignited by being brought into contact with a spiral of iron wire, traversed by an electric current.

For testing a solid or liquid fuel, a gramme of the substance is placed in the capsule, and the plug is screwed down tightly. Oxygen, under pressure, is allowed to enter by the cock, until the manometer shows that a suitable pressure is obtained, generally from 20 to 25 atmospheres. Care must be taken, especially with coal in a finely divided state, to prevent the sample from being displaced, in which case there would be the danger of part escaping combustion. The shell thus prepared is placed in the calorimeter, which contains a known quantity of water, when the thermometer is adjusted, and the Berthelot helicoidal agitator set to work for a few minutes, to bring the whole apparatus to the same temperature, when all is ready for the observation.

The temperature is noted every minute for four or five minutes, and then the charge is fired by electricity. Although the combustion is almost instantaneous, the transmission of heat to the water requires a few minutes. The temperature is noted half-a-minute, then one minute after the ignition, and afterwards every minute, until the thermometer begins to fall, which shows that the maximum temperature has been reached, after which the observations are continued for about five minutes more. The principal elements of the calculation are thus afforded, and especially the sole correction necessary, which is due to the loss of heat sustained by the calorimeter before reaching the maximum temperature. The agitator must be worked regularly during the observation, at the conclusion of which the cock is opened first, and then the shell itself. The inside of the shell is washed with a little distilled water, so as to collect the acid liquid formed during the explosion. It is advisable, when experimenting on substances poor in hydrogen, like coke, and consequently incapable of furnishing by combustion sufficient water to form nitric acid—it is advisable in such a case to put a little water at the bottom of the bomb, otherwise only hypo-nitric acid would be obtained.

For determining the calorific volume of a gas of constant volume, a vacuum is made in the shell, the exact cubic contents of which are known. The shell is then filled once with gas; a fresh vacuum of a few millimetres of mercury is produced, and the shell is filled definitely with the gas at atmospheric pressure and at the temperature of the laboratory, when the operation is completed in the same manner as with solid and liquid fuels. Care must be taken, however, not to so far reduce the quantity of oxygen that the mixture cease to be combustible; with lighting gas five atmospheres of oxygen suffice, and, with the gas of Siemens producers, half an atmosphere will not be exceeded.

M. Mahler then gives examples of the calculation of calorific powers, having chosen them so as to serve as types of the various circumstances which must occur in practice, viz., colza oil, Nixon's navigation coal, a lighting gas made in the laboratory, and the coke of petroleum which, being difficult to ignite, was tested with an auxiliary combustible, viz., naphthaline.

This apparatus gives precise indications that must always be compared one with another, and this without a laboratory or the concurrence of a professional chemist, while the whole apparatus may be placed on a table 5 feet by $2\frac{1}{4}$ feet.

M. Mahler has analysed a large number of coals and other fuels, and has also tested them in the calorimetric shell. His observations led him to the conclusion that the calorific value of solid combustible substances of vegetable origin varies, in round numbers, from 4,500 calories* (wood) to 8,900 calories (bituminous coal) per kilogramme. He also found that the coals of lowest calorific capacity are those which burn with a long flame, their heat of combustion varying from 7,840 calories to 8,570 calories, after which come the gas coals, varying from 8,400 calories to 8,770 calories. The most advantageous coals appear to be generally the bituminous and semi-bituminous varieties, which show from 8,570 calories to 8,870 calories. Some anthracitous coals possess considerable calorific value, while the true anthracites approach, by their heat of combustion, the ordinary flaming coals, giving 8,700 calories to 8,100 calories. The vegetable oils (colza 9,600 calo-

* A calorie is equal to nearly four English heat-units and a kilogramme to 2·2 lb. avoirdupois. As, however, a calorie represents the heat required to raise a kilogramme of water one degree Centigrade, while the English heat-unit measures that of a pound raised one degree Fahrenheit, all that is necessary, to reduce calories per kilogramme to English heat-units per pound, is to multiply by 1·8, the difference between the two thermometrical degrees.

ries) come higher in the scale, while petroleum and lighting gas (11,000 calories) range still higher.

With respect to the question whether the calorific value of fuels may be calculated from their elementary composition by Dulong's law, M. Mahler has found that the mean calculated power of woods and peats differs from the actual power by 10 per cent.; the mean of about forty samples of peat, wood, lignite, coal, and anthracite by 1·1 per cent.; the other coals, without the cannels, by 0·5 per cent.; and the other coals, with the cannels, by 0·2 per cent. He therefore concludes that the calorific value cannot be calculated with sufficiently near approximation for scientific, although it may be for practical purposes, especially in the case of coal, which is by far the most important fuel used in industry.

General Notes.

Swiss Cheese.—The value of the cheese exported from Switzerland in 1891 was £1,544,555, being an increase of £19,268 as compared with 1890, although the actual quantity exported was less than in the preceding year. The value of the cheese exported to France in 1891 was over £438,000.

Milan Electrical Exhibition.—In connection with the International Electrical Exhibition, to be held at Milan in 1894, it is proposed to offer a prize for the most important electrical invention or discovery, especially relating to the transmission of energy to a distance, and its distribution and transformation for industrial uses.

Electric Lighting at Santiago. — The Municipality of Santiago have decided to invite tenders for the installation of electric light in the city; and the *Board of Trade Journal* announces that the Municipality desires that this may be made known in the United Kingdom. Tenders will be received up to the 1st March, 1893.

Kerosene Oil.—The imports into British India last year were 55,499,858 gallons, of which 27,000,000 gallons were from the United States, and 28,250,000 from Russia. For 1891 the imports into China were 39,348,477 gallons from America, and 10,000,000 gallons from Russia. The imports into Japan in 1890 were 42,663,580 gallons.

Railway Speed.—Two consecutive miles have, according to *Engineering*, been run on the Central Railroad of New Jersey in 37 seconds and 38 seconds respectively, corresponding to speeds of 97·3 and 94·73 miles per hour respectively. The train consisted of a combination car, two passenger cars, and a Pullman car. The weight was about 125 tons, or 217 tons including engine and tender.

Technical Education for Painters and Decorators.—A United Conference of Masters and Workmen has been arranged to take place at the Paperstainers'-hall, Little Trinity-lane, on the evenings of January 16th, 17th, and 18th. The Master of the Company will preside on the first night; Lieutenant-General Robert J. Bennett, of Glasgow, on the second night; and Mr. J. D. Crace on the third night.

Exhibition at Rome, 1895-96.—Reference has already been made in the *Journal* (see vol. xl., p. 980) to the Italian General Exhibition and International Exhibition of Fine Arts and Electricity, which is to be held in Rome in 1895-96. The grounds are in the vicinity of "Ponte Milvio," about a mile's distance from the "Porta del Popolo," and close to the new road and park called "Viale Parioli." The Exhibition is intended to commemorate the annexation of Rome to the kingdom of Italy.

Lithographic Stone. — It is stated in the *Journal de St. Pétersbourg*, quoted in the *Board of Trade Journal*, that to the number of mineral riches of the Oural not yet worked are to be added important quarries of lithograghic stone, situated in the district of Krasnooufimsk, province of Perm. These deposits have been known for fifteen years, and the lithographic stone which they yield has been recognised as excellent, but until recently nobody has ventured to work the quarries in question. Last winter the quarrying of the lithographic stone was commenced, and, according to the *Novoe Vremya*, it will be sold in depôts established in St. Petersburg for the purpose.

Vanilla.—It has been estimated that the world's consumption of vanilla is about 230,000 lbs. per annum. That calculation was made a few years ago, since which there has probably been little increase in the requirements, as vanillin, the synthetic product, has usurped the place of the natural drug in many branches of manufacture. But, assuming that the consumption is now 250,000 lbs. per annum, the depreciation which vanilla has undergone during the last two or three years appears fully justified by the increased output; for the crops of Bourbon, Mauritius, and the Seychelles alone are estimated at about 260,000 lbs. in 1891; 200,000 lbs., in 1890; 150,000 lbs., in 1889; 150,000 lbs., in 1888; and 350,000 lbs. in 1887. Add to this the Mexican production, which, in good years, is perhaps 100,000 lbs., and it will be seen there is probably a sufficiency of old stock in the various centres to enable us to do without the 40,000 lbs. a year or so which may be expected from Mauritius.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

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FRIDAY, JANUARY 6, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

On Wednesday evening, the 4th inst., Mr. R. Bowdler Sharpe, LL.D., gave the first of his course of Juvenile Lectures on "The Curiosities of Bird Life." He commenced by describing the wingless birds, or, rather, those birds which had never used their wings, instancing the didunculus, a bird something like the dodo, which took to flying about twenty years ago. He then proceeded to give instances of ornaments where fine feathers are said to make fine birds, showing birds of paradise and humming birds. The variety of the latter birds was great, specimens of different species being found in very small areas. John Gould, the eminent ornithologist and historian of the humming birds, had advertised many years ago that he would give £50 a piece for every specimen of a certain species, but he died before a single bird was found; since his death it has been sent to England. Another instance of curious ornamentation was the umbrella bird, and still another, the bell bird of British Guiana, so-called from its extraordinary note resembling a bell, which had often deceived the traveller into supposing he heard a church bell. The lecturer then gave an account of the many curious kinds of nests produced by different birds, such as the tailor and weaver birds; one of these was the oil bird, so-called because it had an oily taste, when eaten, which made a nest like a Stilton cheese. Another curious instance was the Indian hornbill, the female of which was plastered up in a tree, when laying her eggs, and fed by her mate. Her position was precarious when the male bird was shot, but the sportsman noticed that when this occurred quite a number of hornbills, male and female, were found feeding the bereaved one. Instances of the playing-grounds, in which the male birds showed themselves off before the females, were then given, and the various bower birds were shown. Then followed specimens of curious plumage, and the great difference between the male and female birds was pointed out. A few instances were given, such as the button quail, where the female was larger and more beautiful than the male. A large number of instances of mimicry were then shown, beginning with the butterfly mimicking a leaf, and the moths imitating the wasp. Passing on to the birds, here the examples presented showed not only mimicry of colour, but also mimicry of position, which deceived the most experienced sportsman, and showed intelligent intention to elude capture on the part of the bird. The lecturer ended with some remarks on migration, and alluded to the different routes taken by the swallows, when migrating from various parts of Europe to warmer climates. The lecture was illustrated by a large series of coloured lantern slides.

The second lecture will be delivered on Wednesday next, 11th inst.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d., on application to the Secretary.

Chicago Exhibition, 1893.

FINE ARTS COMMITTEE.

A meeting of the Committee on Fine Arts was held on Thursday, 29th December, 1892. Present: Sir Frederick Leighton, Bart., P.R.A., in the chair; Wyke Baylis, P.R.Soc.B.A., Sir James D. Linton, P.R.I., W. E. Lockhart, R.S.A., W. W. Ouless, R.A., Marcus Stone, R.A., W. Hamo Thornycroft, R.A., Sir Henry Trueman Wood, Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

A meeting of the Committee was also held on Tuesday, 3rd January. Present: Sir Frederick Leighton, Bart., P.R.A., in the chair; J. Macvicar Anderson, P.R.Inst.B.A.,

Wyke Baylis, P.R.Soc.B.A., Sir James Linton, P.R.I., W. E. Lockhart, R.S.A., W. W. Ouless, R.A., Edward J. Poynter, R.A., Sir Henry Trueman Wood, Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

Proceedings of the Society.

CANTOR LECTURES.

GENERATION OF LIGHT FROM COAL GAS.

By Vivian B. Lewes, F.I.C., F.C.S.,
Professor of Chemistry, Royal Naval College.

Lecture III.—Delivered December 5th, 1892.

I have now brought before you the work on which our present ideas as to the source of the luminosity in hydrocarbon flames is based, and I cannot but think that the evidence collected by Davy, Stein, and Heumann, Soret, Burch, and Stokes, has fully established the truth of the solid particle theory first enunciated by Davy.

But in admitting this, we must not overlook the debt which we owe to Dr. Frankland, as although the mass of evidence seems conclusively to point to carbon particles, and not incandescent hydrocarbon vapours, as being the cause of luminosity in coal gas, oil lamp, and candle flames, yet had it not been for his putting forward his theory, and supporting it in the way he did, we should probably never have had the masterly work by which Heumann conclusively established the truth of Davy's hypothesis, or the smaller contributions which have so strengthened its position.

Three years ago I had the honour of delivering before you a course of Cantor Lectures on "Gaseous Illuminants," and whilst searching flame lore in order to find the exact position of our theories as to luminosity, it seemed to me that in the present position of our knowledge, what was really required was to show how and why these all-important carbon particles came to be formed in the flame—was it, as Davy supposed, brought about by the heat of the outer portion of the flame decomposing the hydrocarbons in the interior regions, where air was scanty or altogether wanting, into their constituents; or was it, as others supposed, some unfinished combustion which gave the particles to the flame, and so endowed it with luminosity? Could it be that Frankland was right, and that what had been called solid particles of carbon were in reality the densest possible vapours of hydrocarbons. If so, how could they have been produced from the hydrocarbons we know to be present in the coal gas, and was the temperature of a luminous flame sufficient to cause incandescence of such vapour, and yet not sufficient to decompose it? These and a hundred other like thoughts came as a recreation from duller routine work, and experiments made, whenever time could be found by myself and my assistants, have revealed another step in our flame reactions, and have made clearer changes which before had to be explained by assumptions.

In the last lecture of the last series I had the pleasure of delivering here, I dealt with the products of incomplete combustion which escape into the air when we check the combustion of a flame, by practically putting it out before combustion is complete, by withdrawing the heat of the flame for the raising the temperature of other things in our gas stoves and ovens; and whenever a luminous flame is treated in this way, an insidious and disagreeable odour pervades the room, whilst if an atmospheric or Bunsen burner flashes back and burns "at the bottom" the smell becomes almost unbearable. This curious smell has long since been recognised as that of acetylene, one of the simplest of the gaseous hydrocarbons; and the undoubted presence of acetylene in the products escaping from a cooled flame, and the fact that the incomplete combustion of hydrocarbon gases always gives rise to the formation of this compound, suggested the idea that it might play an important part in the changes taking place in the interior of a flame, and experiments were made to ascertain if any appreciable quantity was formed by the destruction of hydrocarbons in the flame gases.

The fact that the unsaturated hydrocarbons only slowly decrease in the inner zone, and then rapidly disappear in the luminous part of the flame, has naturally suggested the idea that it is to these compounds that the flame owes its luminosity; but, as far as I know, no one has attempted to ascertain whether the unsaturated hydrocarbons present at the top of the inner non-luminous zone are of the same character as those found in the coal gas.

I had just completed working out these points when, in December of last year, Professor Smithells, of the Yorkshire College, Leeds, read a most interesting paper before the Chemical Society, on "The Structure and Chemistry of Luminous Flames," and as this

was published a month before my results, it will be better to take it in its historical sequence. The author devised a very beautiful experiment, by which he was able to show that the Bunsen flame consisted of two distinct cones of combustion, which could be separated widely apart, the reason he gives being that—

"When a Bunsen flame is burning at the top of a tube in the ordinary way the coal gas is in such excess that the mixture within the tube is scarcely explosive. If now the proportion of coal gas to air be diminished, the mixture within the tube becomes more explosive, and the initial velocity of inflammation of this mixture increases as the proportion of air is increased up to a certain point. Long before enough oxygen is mixed with the gas for its complete combustion, the explosibility of the mixture has reached such a point that the velocity of inflammation is greater than the velocity of efflux, from the tube, and so the flame is differentiated into two cones, one of which descends the tube and marks the margin of the explosive mixture. The other cone marks the area of the combustion of the combustible gases which have escaped combustion in the lower cone and are burning at the top of the tube in free air. Now the rate at which the inner cone will descend the tube will depend upon several conditions, one of which is the temperature, another the diameter of the tube, and these conditions suggested a means of arresting the lower cone of flame. By heating the glass tube with a blow-pipe flame, at a point about a foot below the top, it was found possible to arrest the inner cone when reascending, the high temperature producing locally a velocity of inflammation greater than that at points above or below, and so fixing the flame. The second method suggested by the foregoing considerations was simply to diminish the diameter of the tube at one point either by means of a metal diaphragm or by slightly drawing out the tube so as to cause a constriction. At the narrow part of the tube, the velocity of the ascending gas mixture is obviously greater than elsewhere, and hence a flame which will descend the wider part of the tube will be arrested at this point. . . With this apparatus, the flame could be divided with the greatest ease, and the two regions of combustion kept separate for any length of time."

Having in this way separated the cones of various hydrocarbons burning with excess of air, he was able to withdraw samples of the interconial gases, and subject them to analysis; and he found that the main chemical change occurring in the inner cone under these conditions consists in the combustion of the hydrocarbons to form carbon monoxide and water with smaller quantities of carbon dioxide and hydrogen; and he also notes that, when the air was insufficient to destroy luminosity, some acetylene comes from the inner cone.

In dealing with the question of the structure of luminous flames, he points out that—

"The glow of the carbon in the yellow region is due to the heat of its own combustion, and is increased, probably, by the concomitant combustion of hydrogen. The view occasionally met with, that the carbon is glowing only by the heat of the burning hydrogen, is manifestly erroneous. The carbon is in the solid state, and must either undergo the usual glowing combustion, or else escape from the flame unburned. As it does not do the latter to any appreciable extent, it must burn, and the cessation of its combustion as a solid mark the limit of the yellow or luminous region of the flame.

"The blue region has been unanimously regarded as a part of the flame where the hydrocarbons are mixed with sufficient air to cause immediate combustion without the separation of carbon.

"The faintly luminous portion which entirely surrounds the flame was not referred to by Davy as distinct from the blue region. Berzelius describes it, and states 'that it is in this outer part that the combustion of the gases is completed and the heat most intense.' Waldie states that it consists of 'the proper combustible mixture,' and is the hottest part of the flame, and to its heat is to be attributed the separation of the carbon within the flame.

"No intelligible distinction appears to have been made between this region and the blue one until 1861, when Kersten attempted to do so; and even his description is not easy to grasp. He appears to have regarded the faintly luminous region as the place in which hydrogen and carbon monoxide coming from the yellow region undergo combustion, ignoring the fact that it surrounds not only the yellow region, but the blue one as well.

"I have only met with one other attempt to explain this part of a luminous flame as distinct from the blue portion, and have not been able to trace it beyond the text-books. It ascribes this faintly luminous region to products of combustion—carbon dioxide and water—mixed with air, and raised to feeble incandescence; that is, it is not a region of chemical action at all. If for no other reasons, this explanation could scarcely be maintained in the face of the observations made by Siemens, that such products of combustion have no perceptible luminosity at 1,500°.

"The best way to study flame structure seems to me to consist in tracing the development of the flame. By using a very small quantity of combustible—that is to say, in the case of gases, by almost turning off the tap, and, in the case of solids and liquids, by having a very close-cropped wick—we obtain a tiny flame, which is ordinarily called non-luminous. It consists of a hollow, bright blue cone, surrounded by a lilac-coloured border. If more gas be turned on, or if the wick becomes longer, a luminous spot is

developed in the flame. This spot is at first a small fraction of the whole flame, but, as the supply of combustible is increased, it rapidly extends, the original inner cone becomes a 'vestige,' and forms, in fact, the blue region. Still, the original formation is evident, the luminous spot being indented at points corresponding to it.

"The question now arises, is the non-luminous flame a single or a double cone, and, in any case, what chemical changes are taking place in it?

"I think an answer to this question may be obtained by carefully watching the change undergone by a luminous flame when air is gradually added to the gas prior to combustion. For this purpose a small flame from a Bunsen burner, with the air holes at first closed, may be employed. If attention be fixed on the blue and on the faintly luminous regions of the flame, and the air holes be now slowly opened, the flame loses luminosity, and the two regions grow more distinct, and ultimately become without any perceptible break of continuity in the process, the inner and outer cones of the ordinary Bunsen flame.

"If the conclusion be admitted that the blue and the faintly luminous regions of an ordinary flame correspond to the inner and outer cones of a Bunsen flame, then we must consider the blue region to mark incomplete combustion—CO, H_2, CO_2, and H_2O being the chief substances there originating —and the faintly luminous part to mark completed combustion—the CO and H_2 above-named being burnt to CO_2 and H_2O.

"In other words, I conclude that there is no essential difference in kind between an ordinary luminous flame and a so-called non-luminous flame. The latter may be regarded as a gas-air flame with the blue and non-luminous regions at a maximum, whilst the luminous flame is to be regarded as a gas-air flame, with the blue and non-luminous parts at a minimum, and the yellow luminous region at a maximum.

"As it has been repeatedly shown that the dark central part of a luminous flame is a region of no combustion, there only remains now one question for solution, How is the carbon separated in the luminous yellow region?"

And Professor Smithells finally describes the development of a luminous hydrocarbon flame as follows:—

"The hydrocarbon issues from the burner or wick —let us suppose—as a cylindrical column. This column is not sharply marked off from the air, but is so penetrated by the latter, that we must suppose a gradual transition from the pure hydrocarbon in the centre of the column to the pure air on the outside. Let us take a thin transparent slice of the flame, near the lower part of the wick, or close to the burner. At what lateral distance from the centre will combustion begin? Clearly, where enough oxygen has penetrated the column to give such partial combustion as takes place in the inside of the Bunsen burner. This, then, defines the blue region. Outside this the combustion of the carbon monoxide hydrogen, and any hydrocarbons which pass from the blue region, takes place, and constitutes the faintly luminous region. These two layers form a sheath of active combustion, surrounding and intensely heating the hydrocarbons in the central parts of the column. These heated hydrocarbons rise, and are heated to higher temperatures as they ascend. They are accordingly decomposed, with the separation of carbon in the higher parts of the flame, giving us the yellow region; but there remains a central core, in which neither is there any oxygen for combustion nor sufficiently high temperature for decomposition. This constitutes the dark region of unburnt gases. A flame is, however, not cylindrical, but has a conical, or, in the case of a candle, an inverted peg-top shape. Again, the blue region only surrounds the lower part of the flame, whilst the faintly luminous part surrounds the whole. The above explanation is therefore not complete. Let us suppose that the changes have gone on in the small section of the flame exactly as described, and consider how the processes will differ in parts above this section. The central core of unburned gases will pass upwards, and we may treat it as a new cylindrical column, which will undergo changes just as the original one, leaving, however, a smaller core of unburned gases, or, in other words, each succeeding section of the flame will be of smaller diameter. This gives us the conical structure of the flame. Again, the higher we go in the flame, the greater proportionally is the amount of separate carbon, for we have not only the heat of laterally outlying combustion to effect decomposition, but also that of the lower parts of the flame. The lower part of a luminous flame is accordingly cooler and contains less separated carbon than the upper. Now, where the hydrocarbons are cool until mixed with sufficient air for combustion—that is in the lower parts of the flame—we have every facility for the occurrence of the chemical changes to which the existence of the blue region has been ascribed, and the blue region is here most evident, whereas in the upper parts of the flame, where the quantity of hydrocarbon decomposed—with separation of carbon—by heat is relatively much greater, there is not enough left to form outside the yellow part, the mixture to which the blue region of the flame is due. The blue region therefore rapidly thins off as we ascend the flame. But whether the first combustion taking place within the flame is that of the undecomposed hydrocarbon with limited oxygen, we may be sure that the products will contain carbon monoxide, and probably hydrogen, and we shall therefore have all round the flame a faintly luminous region of completed combustion. In this way then, we may reasonably acconnt for the existence, position, and relative sizes of the four regions of an ordinary luminous flame."

My own work on the subject, which I think

supplies the true answer to Professor Smithell's query of "How is the carbon separated in the yellow luminous region?" I will now bring before you.

In attacking this point I felt that the changes and actions must be sought for in the non-luminous zone of the flame itself, and chose as the subject for the experiments an ordinary coal-gas flame.

The coal gas used was that supplied by the South Metropolitan Gas Company, and analyses gave as its composition:—

Hydrogen	57·08
*Unsaturated hydrocarbons	4·38
Saturated hydrocarbons	33·99
Carbon monoxide	2·63
Carbon dioxide	0·79
Nitrogen	0·96
Oxygen	0·15
Carbon bisulphide	0·02
	100·00

And this gas, when burnt in a standard London Argand at the rate of 5 cubic feet per hour, is of an illuminating value which averages 16·3 candle-power.

The gas was burnt at the end of an open tube, and the flame gases were aspirated from the centre of the flame by means of a small platinum tube 2 mm. in diameter, and were led into a glass bulb-tube, in which the sample for analysis of the total hydrocarbons was collected, and then through two Volhard's absorbing bottles containing 20 cc. of concentrated ammoniacal silver nitrate solution. This absorbs the acetylene with formation and precipitation of silver acetylide and silver, the latter being formed owing to the reducing action of the carbon monoxide, two absorbing vessels being quite sufficient to prevent any traces of the gas escaping absorption. The contents of the two bottles were filtered, the precipitate of silver acetylide carefully washed with water, and then treated on the filter very cautiously with dilute hydrochloric acid, until all action ceases. Acetylene is given off, and the precipitate then consists of a mixture of silver chloride and metallic silver. This, after washing, is digested with dilute ammonia, and the ammoniacal solution, after filtration, is then treated with nitric acid to precipitate the chloride, which is weighed in the usual manner, 1 gram of silver chloride corresponding to 0·09 gram or 87·03 cc. of acetylene (Winkler).

* Containing acetylene 0·035.

Acetylene formed during the Incomplete Combustion taking place in the Interior of a Luminous Flame.

	Total unsaturated hydrocarbons.	Acetylene.
	Per cent.	Per cent.
Gas in burner	4·38	0·035
½ an inch above rim of burner	4·00	0·340
1½ inches above rim of burner	1·53	0·560
Tip of inner cone	1·98	1·410
Centre of luminous zone	0·45	0·045
Tip of luminous zone	Nil.	Nil.

Showing that in the interior of the luminous flame the hydrocarbons at once begin to undergo decomposition, giving rise to acetylene, which, by the time the top of the inner non-luminous zone is reached, constitute over 70 per cent. of the unsaturated hydrocarbons present. A small proportion of the other hydrocarbons, however, remains undecomposed, and penetrates into the luminous zone, where it and the acetylene are both decomposed by the higher temperature attained, carbon is liberated, and this being, for a moment, heated to incandescence, gives luminosity to the flame.

An ordinary flat flame was now experimented with, the gases being withdrawn and analysed in the same way as before.

Acetylene formed in the Inner Zone of a Flat Flame from a No. 7 Bray Burner.

Portion of Flame.	Total unsaturated hydrocarbons.	Acetylene	Other unsaturated hydrocarbons.
	Per cent.	Per cent.	Per cent.
½ an inch from top of burner ...	3·565	0·115	3·450
1¼ ins. from burner	2·063	1·303	0·760
1¾ " " "	1·393	1·133	0·260
2¼ " " "	trace	trace	—

Showing that by the time the top of the non-luminous portion of the flame was reached over 81 per cent. of the hydrocarbon present had been converted into acetylene.

In such a flame luminosity commences just above the inch and three-quarters above the burner; and, if luminosity is caused by acetylene, it is natural to ask, why should it not

have commenced at an inch and a quarter ?-- a spot where the acetylene is present in larger quantity than at the higher point. The reason for this is, that in order to cause luminosity, a temperature must be obtained at which the acetylene is dissociated, and the point at which this takes place marks the commencement of luminosity. If this temperature is not attained, then the acetylene in the presence of oxygen burns away with a non-luminous flame, or, if no oxygen is present, polymerises into a number of higher hydrocarbons. If, on the other hand, a sufficiently high temperature is reached to cause dissociation, the liberated carbon becomes incandescent, chiefly from its own combustion, but partly, also, from the combustion of the hydrogen liberated at the same time, and luminosity is the result.

The temperature needed to cause the dissociation of acetylene varies with the amount of dilution; the more diluted it is, the higher being the temperature necessary to break it up; whilst the larger the quantity of acetylene, the lower the temperature needed to cause its dissociation, and the smaller, therefore, the inner non-luminous zone of the flame.

In the flame from ordinary coal gas there is only from 1·1 to 1·3 per cent. of acetylene found in the inner zone, and, in this highly-diluted condition, it requires a temperature of close upon 1,200° C. to break it up; whilst in other flames richer in hydrocarbons, and therefore richer in acetylene in the inner zone, the temperature required is not so high. For example:—

	Flame of	
	Coal gas.	Paraffin lamp.
Percentage of acetylene	1·133	2·222
Temperature at commencement of luminous zone	1,267°C.	1,062°C.

The fact that unless the requisite temperature is reached, the acetylene burns away with non-luminous combustion is, I think, clearly shown by the following experiment.

The flame of burning alcohol contains more than half the quantity of acetylene that a good gas flame contains, and yet the combustion is practically non-luminous. If a dish containing some alcohol be placed under a bell-jar, it burns with a flame having slightly luminous edges, and the temperature of the flame in this condition is 1,220° C. If now a glass plate be put over the mouth of the bell-jar for a few moments, the mixing of the products of combustion with the air lowers the rate of combustion, and the temperature of the flame falls to 1,050° C., the flame becoming perfectly non-luminous, whilst if oxygen be admitted to the bell-jar, the combustion is increased and the temperature rapidly rises to 1,510° C., the flame becoming nearly as luminous as a coal-gas flame, and depositing carbon on any cold surface held in it.

Again, if a small luminous gas flame be allowed to play upon the bottom of a platinum dish, so much heat is abstracted from the flame that the temperature falls below the point necessary to break up the acetylene and the flame becomes non-luminous, whilst if the flame is allowed to remain in contact with the metal until the dish is red-hot the luminosity returns, and the same effect may be produced by heating the interior of the dish with a blow-pipe flame. This experiment was devised by Heumann to show the effect of cooling on luminosity.

In every flame that I have examined which owes its luminosity to the presence of hydrocarbons, these bodies are converted into acetylene before luminosity commences in the flame, and every gaseous hydrocarbon which can by heat be made to deposit carbon is converted into acetylene before any deposition takes place.

Many of the hydrocarbons present in coal gas are known to give out heat during their decomposition, but probably the most endothermic of these compounds is the acetylene, Thomson having shown that no less than 55,010 units of heat are absorbed in the formation of 26 grains of acetylene, whilst only 10,880 disappear in the production of 28 grains of ethylene, and it is this which renders so easy its decomposition by heat, or as shown by Berthelot, even by detonation, into carbon and hydrogen.

The fact that acetylene is formed from the gaseous hydrocarbons present in illuminating gas prior to the emission of light, does not, however, by itself in any way disprove Frankland's theory that luminosity is due to very heavy hydrocarbon vapours and not to solid particles of carbon, as the well known tendency of the acetylene to polymerise into higher bodies might be taken as an explanation of the presence of sufficiently dense hydrocarbons in a flame given by, say, pure ethylene.

In order to determine whether or no the

acetylene formed in the earlier stages of the flame renders the flame luminous, by liberating carbon during dissociation, as required by Davy's theory or by forming heavier hydrocarbons, a long series of experiments was made to ascertain the effect of heat upon the hydrocarbons present in coal gas, and by specially devised apparatus to measure the actual temperature to which the gases were being heated, and to collect and analyse the resulting products.

In 1805, William Henry showed that when electric sparks are passed for some time through ethylene, the volume increased, and, although the action was far from complete, he was able to show that, at the temperature of the spark, all the ethylene which had disappeared had decomposed according to the equation—

$$C_2H_4 = C_2 + 2H_2,$$

the carbon being deposited on the poles and on the sides of the tube. The same thing was noticed by other observers, and in 1860, H. Buff and A. W. Hofmann showed that by heating ethylene by means of a platinum wire sealed into a tube containing the gas, and through which a powerful current was passing so as to raise it to redness, a deposition to carbon was produced, but no increase in volume, from which they conclude that the ethylene has decomposed into marsh gas and carbon—

$$C_2H_4 = C + CH_4$$

an equation which has been reproduced in every text-book since that date. They then passed electric sparks through the gas, and in twenty-five minutes the volume of the gas was nearly doubled, and analysis showed that no marsh gas was present in the residual gas, which consisted of hydrogen, having, as they say, an unpleasant odour and burning with a slightly luminous flame.

No secondary products have been observed by anyone when passing electric sparks through ethylene, except De Wilde, who found small quantities of acetylene, but Berthelot has obtained traces of acetylene from carbon and hydrogen alone under these conditions. The experiments of Henry support the above conclusion, for although the decomposition was by no means complete, the only products obtained were carbon and hydrogen, together with undecomposed ethylene.

At temperatures lower than that of the electric arc the decomposition of ethylene is not so simple. This is indicated by the experiments of the Dutch chemists, of Grove, and of Buff and Hofmann, to which reference has been made. The latter chemists obtained marsh gas and carbon by use of a heated platinum wire. The experiments of Grove are not in strict accordance with this, but, as the spirals were not necessarily heated to the same temperature, perfect agreement could not be expected. The experiments indicate, however, that the next stage preceding complete separation is a decomposition into marsh gas, without the formation of any more complex products.

It has been noticed by various observers, amongst whom is Magnus, that at still lower temperatures much more complex actions take place, and at about 400° C. the heating of ethylene gives rise to liquid products, which Berthelot has shown not to be a single substance but a mixture of several liquids, among them benzine, styrene, and other liquids with higher boiling points. He found a trace of acetylene in the gaseous residue, and claimed that a large portion of ethane was formed, and on this basis supposed that the decomposition of ethylene by heat consists in a splitting of two molecules of ethylene into acetylene and ethane, and that the formation of liquid products is due to a subsequent condensation of the acetylene into more complex products.

Day also made a number of experiments upon the changes effected in ethylene by heating, and comes to the following conclusions :—

1. Ethylene undergoes change by the action of heat at a temperature very much lower than has been observed in previous investigations.

2. The temperature at which ethylene begins to alter in constitution is about 350° C.

3. The change at this temperature consists in condensation without the formation of members of any series of hydrocarbons having a different per-centage of carbon and hydrogen from ethylene. The change is slow, requiring at least twenty hours before it ceases, and it is not then complete.

4. If ethylene is heated to 400° for a sufficient length of time, it is entirely decomposed with formation of marsh gas, ethane, and liquid products.

I have been working upon the decompositions which ethylene undergoes, and I find that it decomposes in two ways, according to the method in which heat is applied. If the gas be kept sealed up in a glass tube for a very long time, at a temperature of 400° C., it decomposes into ethane, methane, and acetylene, the latter then polymerising into the various compounds noticed by Berthelot; but

that, on the other hand, if the ethylene is passed through a narrow tube heated to a higher temperature, so as to represent the changes which it would undergo on passing up through the non-luminous zone of a flame, the decompositions are somewhat different, no ethane being formed, but methane and acetylene.

Ethylene passed at the rate of 4 to 5 cc. per minute, through a tube 2 millimetres in internal diameter, undergoes no apparent change until the temperature rises to between 800° and 900° C., it then breaks down to methane and acetylene, and simultaneously with the formation of acetylene, heavy vapours appear which can be condensed, and in which benzene and naphthalene are conspicuous, as well as a heavy and highly fluorescent oil of high boiling point. Berthelot found that these substances were formed when acetylene was heated for some time at the temperature at which glass softens, and he also recognised among the products cinnamene C_8H_8, and retene $C_{18}H_{18}$, so that there seems very little doubt but that in passing the ethylene through a heated space in which the temperature does not rise above 900° C., methane and acetylene are first found, and the latter at once polymerises into the heavier hydrocarbons. The amount of acetylene found in the products of the experiment rarely exceeds 1 per cent., as the polymerisation occurs almost simultaneously with its formation, but the proportion of ethylene decomposed, and the amount of methane found in the products of decomposition, point to the initial action of heat at this temperature being

$$3C_2H_4 = 2 (C_2H_2 + 2 (CH_4).$$

On increasing the temperature from 900° C., slowly up to 1,000° C., the same action continues, no hydrogen appears in the products of decomposition, and no carbon is deposited but the formation of oil and solid hydrocarbons is more abundant. Between 1,000° and 1,100° C., a trace of hydrogen appears and a little carbon begins to deposit with the oil, this increasing with rise in temperature up to between 1,300°, and 1,400° C., by which time all formation of oil has ceased. Carbon is deposited in larger quantities, and the residual gas consists of hydrogen with a little methane. The temperature at which oil disappears is about 1,200° C., and the proportion of acetylene formed at this temperature is larger than at any of the lower ones.

It is evident, therefore, that, if the temperature existing in the luminous portion of the flame exceeds 1,200° C., the luminosity cannot be due to such hydrocarbons as are formed from the acetylene, but that carbon will be present in abundance.

I have made several analyses of the carbon so deposited, and find that the hydrogen in it varies from 1 to 3 per cent.; and, as there is no fixed ratio, I think there is not the slightest foundation for imagining that it is in combination; indeed, Stein's work upon this point is fairly conclusive, and any one who has attempted to prepare hydrogen free carbon from sugar, or other similar body, will realise the intense power which freshly liberated carbon has of occluding and holding hydrogen.

Ethane, which is present in illuminating gas in larger proportion than is generally supposed, breaks up even below 800° C. into ethylene and hydrogen—

$$C_2H_6 = C_2H_4 + H_2.$$

and the ethylene behaves as before on increase of temperature. Methane, which is not only present in very large quantities in the original gas, but is also produced during the decomposition of the ethylene, is apparently unaffected by heat until a temperature of 1,000° C. is reached, when hydrogen and unsaturated hydrocarbons begin to appear in small traces. Acetylene, being the chief of these, this action continues and increases; so that, at about 1,500° C., considerable quantities of acetylene are formed, which break down to hydrogen and carbon. With methane, as with ethylene, the first trace of acetylene found in the products is also accompanied by the formation of oils and heavy considerable vapours. Methane is not so easily converted into acetylene as the other hydrocarbons, and requires a higher temperature to bring about the change; but the fact that it does do so at high temperatures fully explains the facts first observed by Dr. Percy Frankland and Mr. Lewis Thompson that, although methane, when burnt by itself, has but a very feeble power of illuminating, yet that, when used as a diluent of heavier hydrocarbons, it greatly increases the light-emitting power of the flame.

In order to apply the knowledge these experiments give of the changes taking place in the hydrocarbons present in coal gas during their flow through the heated channel in the interior of the flame, it is necessary to map out the temperature existing in a luminous flame, and the flat flame from a Bray burner—No. 7—lends itself conveniently to this purpose.

Using the Le Chatelier thermo-couple, described by Prof. Roberts-Austen at the last

meeting of the British Association, and making only one short twist of the wires to give contact, and then coating them with hard glass, it is possible for nearly a minute to get the temperature in the portion of the flame in which the short twist is plunged, and if thin wires are used the loss by conduction is very small. Of course, if the part of the flame through which the glass-coated wires pass is at a higher temperature than the portion around the twist, as the heat penetrates the glass it will give too high a reading, but for the first 30 or 40 seconds there is no fear of this.

With this arrangement I was able to map out the temperatures existing in the flat flame, in which I had traced out the changes taking place in the constituents of the gas, and I found that the temperature rapidly rose from 500° C., half an inch above the burner, to a little over 1,200° C. at the commencement of the luminous zone, the luminous edges having a temperature of 1,216° C., and these temperatures were further increased in the luminous zone until near the top of the flame 1,368° C. was reached. This at once gives us the secret of the luminosity. From the mouth of the jet and up to a temperature of 1,000° to 1,200° C. we have the formation of acetylene from the original hydrocarbons, but the moment the requisite temperature is reached by the combustion of the hydrogen and the carbon monoxide, the acetylene decomposes with a further rise of temperature, and the carbon, heated to incandescence, radiates heat and light.

In the experiments with the hydrocarbons the gases were passing through a heated space six inches long, kept at a constant temperature, in the flame they are passing through a space 1·75 inches long with a rapidly increasing temperature, so that instead of the acetylene becoming polymerised to any great extent, it reaches a temperature at which dissociation takes place almost immediately it is formed.

Experiments with hydrogen-borne benzine vapour show that at a temperature of 1,200° to 1,300° C., it is reconverted to acetylene and this then at once breaks down to carbon and hydrogen, and the same happens with any other heavy vapours formed in the inner zone; and these bodies, formed probably in minute quantities by polymerisation, together with any remaining methane, are reconverted into acetylene, and deposit their carbon as soon as the necessary temperature is reached, and this supplies a fresh quantity of carbon particles to the upper portion of the luminous zone, and so increase its size.

The careful analyses of Hilgard, Landolt, and Blochmann, made to determine the interactions taking place in various flames, are in their main features in close accordance with a long series of analyses of the flame gases which I have made, and one of the most striking features of these is the comparatively slow rate at which the heavy hydrocarbons disappear, as compared with the other constituents of the original gas. This I find to be chiefly due to diffusion, which causes the hydrogen and methane to find their way to the outer skin of the flame first, and it is these bodies therefore, which bear the brunt of the earlier combustion, and yield the heat which bakes the heavy hydrocarbons, ascending straight upwards from the burner, into acetyline.

If three concentric tubes be placed half an inch above an open tube from which coal gas is issuing, and the gas from each is withdrawn and analysed, it will be found that, on comparing them with the original gas, the action is most marked; the gas in the outer tube being practically a mixture of air with hydrogen, whilst, in the inner tube, the unsaturated hydrocarbons have risen from 3·56 to 4·53.

All analyses of the flame gases also show that the hydrogen burns first, and that next in rapidity of burning is the methane; and Prof. Smithells advances the theory that, in the incomplete combustion taking place in the flame, the hydrocarbons burn to carbon monoxide and hydrogen.

As has already been shown, the proportion of heavy hydrocarbons consumed before conversion into acetylene and then dissociation into carbon and hydrogen is very small, and the principal hydrocarbon undergoing combustion in the flame is methane. The analyses of Landolt, Hilgard, Blochmann, myself, and Smithells, all show that a large increase in the carbon monoxide undoubtedly does take place; the higher one ascends in the flame until the luminous portion is reached; and also it is probable, from the same analyses, that hydrogen is generated by some action in the outer layer of combustion, as, in spite of its rapid combustion at the base of the flame, as shown by the large per-centage of water vapour formed there, it keeps reappearing for some little distance up the flame, and it is to explain the joint appearance of carbon and hydrogen that Prof. Smithells brings forward his theory that carbon burns to carbon monoxide, setting free the hydrogen from the hydrocarbons.

There is not the slightest doubt, from the work done by Dalton, Blochmann, E. von Meyer, and Dixon that, if you explode together gaseous hydrocarbons with a limited supply of oxygen, you obtain carbon monoxide and hydrogen; and it is also shown by H. H. Baker's experiments that carbon burns first to carbon monoxide; but I fail to see that any such theory is necessary to explain the actions taking place in a flame. If we analyse the gases present in a flame three-quarters of an inch above the burner, which is about the point at which increase of carbon monoxide commences, although it is not marked until 1½ inches up the flame, we find that, in the outer zone of the flame, we have—

	Per cent.
Water vapour	24·65
Methane	8·35

A little deeper in the flame we get—

	Per cent.
Water vapour	17·94
Methane	21·51

And from this point, up to 1½ inches, you have the temperature rapidly rising from 751° C. to 1,100° C.; and it is a well known fact that, if heavy hydrocarbons and water vapour are heated together, they yield carbon monoxide and hydrogen; indeed, it is the most expensive method of making water gas, and wrecked one process for the manufacture of illuminating water gas; and one would expect the same thing to happen when methane and water vapour are heated to this temperature.

In order to try if this were so, methane was passed through water just below the boiling point, and then through a tube heated to 1,000° C., the resulting gases being then analysed, when it was found that the methane and water vapour had interacted to form hydrogen, carbon monoxide, and carbon dioxide; and I should think that this is a far more likely cause of the effects produced in the flame.

Taking the facts which I have now laid before you, we may, I think, fairly fully explain the actions that take place in the flame and lead to luminosity. As the gas leaves the jet, the hydrogen rapidly diffuses to the outer edge of the flame and burns, the methane doing the same but rather more slowly. The combustion of these gases raises the temperature 500° C. in the first half-inch, whilst before another half-inch has been traversed 1,000° C. is reached, and the chemical changes in the hydrocarbons are progressing rapidly, the unsaturated hydrocarbons and higher members of the saturated hydrocarbons being rapidly converted into acetylene. If the temperature of the flame were not allowed to rise above 1,000° C., this acetylene would be nearly all polymerised into benzene, naphthalene, diphenyl, and other complex bodies, which would be slowly burnt up without liberation of carbon, and a non-luminous flame would result. In the case of a gas flame, however, instead of remaining at 1,000° C., the temperature rapidly rises to 1,200° C., with the result that instead of polymerising into more complex bodies most of the acetylene formed, at once splits up into carbon and hydrogen, and the former heated to incandescence by combustion gives the luminosity. It is the attainment of this temperature that marks the limit of the non-luminous zone. If this were the only action however, the luminous zone would be very short. The bodies, however, formed from the acetylene before 1,200° C. was reached, and the methane, of which some still remains unburnt, are converted into acetylene at a still higher temperature, *i.e.*, 1,300° C., and this being reached near the top of the luminous zone, yields a fresh supply of carbon, and so increases the height of the light-yielding portion of the flame.

In producing the luminous flame, therefore, there are two main factors to be observed, first to use such compounds as shall be most easily converted into acetylene, and secondly, to attain as quickly as possible as high a temperature as practicable.

Obituary.

William Hudson.—Mr. Hudson, a member of the Society of Arts of 36 years' standing, died on 2nd March, 1892. He was born in London 26th February, 1813, and about 1827-8 was articled to Mr. Hood, architect and surveyor. About the year 1836 he commenced business as an architect, at 19, Benet's-hill, where he remained until 1889. His architectural practice consisted chiefly in the erection of warehouses and City premises, but he was often employed as a valuer and in arbitration cases. For half a century he acted as Surveyor in London to the West of England Fire-office, and at one time was Assessment Surveyor to the Commissioners of Sewers. He was also Surveyor to the Saddlers' Company and a Fellow of the Surveyors' Institution.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

JANUARY 18.—BENNETT H. BROUGH, Assoc. R.S.M., F.G.S., "The Mining Industries of South Africa."

JANUARY 25.—WYKE BAYLIS, F.S.A., P.R.S. Brit. Artists, "The Fine Arts in Relation to the Sanitary Condition of our Great Cities." BENJAMIN WARD RICHARDSON, M.D., F.R.S., will preside.

FEBRUARY 1.—WILLIAM KEY, "The Purification of the Air Supply to Public Buildings and Dwellings."

FEBRUARY 8.—PROF. FRANK CLOWES, D.Sc., "The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air."

Papers for subsequent meetings, the dates of which are not yet fixed :—

"On some Points in the Chemical Technology of Oil Boiling, with an account of a New Process for Preparing Drying Oils, for Decorators' and Artists' use." By PROF. W. NOEL HARTLEY, F.R.S.

"Transatlantic Steamships." By PROF. FRANCIS ELGAR, LL.D.

"Tele-photography." By THOMAS R. DALLMEYER.

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

JANUARY 12.—HERBERT THIRKELL WHITE, I.C.S. (Burma), C.I.E., "Upper Burma under British Rule." Major-Gen. Sir GEORGE STEWART WHITE, K.C.B , K.C.I.E., V.C., will preside. The paper will be illustrated with lantern views.

JANUARY 19.—J. BARR ROBERTSON, "The Currency Problem." Sir THEODORE CRACRAFT HOPE, K.C.S.I., C.I.E., will preside.

FEBRUARY 16.—Sir WILLIAM WILSON HUNTER, K.C.S.I., C.I.E., LL D., "Ten Years of Progress in India." The MARQUIS OF RIPON, K.G., G.C.S.I., C.I.E., will preside.

MARCH 9.—JERVOISE ATHELSTANE BAINES, I.C.S. (Bombay), "Caste and Occupation at the last Census of India." The LORD REAY, G.C.S.I., G.C.I.E., will preside.

APRIL 6.—The Hon. Sir EDWARD N. COVENTRY BRADDON, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisation."

APRIL 27.—Sir JULAND DANVERS, K.C.S.I., "Indian Manufactures." Sir ALEXANDER WILSON, formerly President of the Bengal Chamber of Commerce, will preside.

MAY 11.—Sir RAYMOND WEST, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results."

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock :—

JANUARY 17.—EDWARD J. HOWELL, "Mexico Past and Present."

FEBRUARY 28.—W. B. PERCIVAL, Agent-Gen. for New Zealand, "New Zealand."

MARCH 21.—CECIL FANE, "Newfoundland."

APRIL 18.—H. A. MCPHERSON, "The Philippine Islands."

MAY 2.—E. DELMAR MORGAN, "Russian Industrial Art."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

JANUARY 24.—HUGH STANNUS, F.R.Inst., B.A., "The Theory of 'Storiation' in Art." W. H. JAMES WEALE will preside.

FEBRUARY 7.—WILTON P. RIX, "Pottery Glazes: their Classification and Decorative Value in Ceramic Design." Sir HENRY DOULTON will preside.

FEBRUARY 21.—T. R. SPENCE, "Wall-papers and Stencilling." LEWIS F. DAY will preside.

MARCH 14.

APRIL 11.—PROF. PAUL SCHULZE, "History and Development of Pattern Designing in Textiles." THOMAS WARDLE will preside.

MAY 9.—W. M. FLINDERS PETRIE, "Primitive Art in Egypt."

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

PROF. J. A. FLEMING, M.A., D.Sc., F.R.S., "The Practical Measurement of Alternating Electric Currents." Four Lectures.

LECTURE I.—JANUARY 30.—*The Measurement of Alternating Current Strength.*—Definitions—Graphic representation of periodic currents—Experimental description of current curves—Analysis and synthesis of periodic currents—Thermal ammeters—Electrodynamometers — Kelvin balances — Copper - disk amperemeter — Electro - magnetic instruments for alternating current instruments—Evershed's, Nalder's, Elihu Thomson's, Dobrowolsky's types of ammeters —Impulse dynamometers—Measurement of very small alternating currents—Methods of calibrating alternating current ammeters.

LECTURE II.—FEBRUARY 6.—*The Measurement of Alternating Current Potential.*—Definitions of inductance and impedance—Laws of current flow in inductive circuits — Construction of non inductive resistances — Electrostatic and electrodynamic voltmeters—Voltmeters of Kelvin, Ayrton, Swinburne, Cardew, Siemens, Elihu Thomson, Evershed, Nalder, and others—Alternate current potentiometer—Employment of electrostatic voltmeters and non-inductive resistances for current measurements—Standardisation of high-tension voltmeters—Measurement of

capacity of condensers and concentric cables—Capacity effects in cables and condensers.

LECTURE III.—FEBRUARY 13.—*The Measurement of Alternating Current Power.*—Apparent and real power—Power factor of a circuit—Power-meters or wattmeters—Electrostatic and electrodynamic forms of wattmeter—Wattmeters for inductive circuits—Wattmeters employed on high tension circuits—Methods of testing efficiency of alternators and transformers—Methods of regulating pressure on testing circuits.

LECTURE IV.—FEBRUARY 20.—*The Measurement of Alternating Current Energy.* — Alternating current ergmeters—Meters for energy: Shallenberger, Thomson, Brillé, Frazer, Ferranti — Meters for quantity: Mengarini, Richard, Frazer—Watt-hour meters or high tension primary circuits—Methods of measuring total output of alternating current stations —Efficiency of supply—Conclusion.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday Evenings, at Eight o'clock:—

PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

LECTURE I.—JANUARY 13.—Commercially available sources of Mechanical Energy—Conditions in which development at Central Stations and distribution is demanded—Steam power fuel consumption—Cost—Influence of variability of load on choice of steam machinery—Cases in which internal furnace engines have an advantage—Storage of power—Battery storage—Thermal storage.

LECTURE II.—JANUARY 20.—Water power—Increase of availability of water power if transmission s possible—Types of water motors—Governing of hydraulic motors—Cost of water power—Storage of power by reservoirs and accumulators—Systems at Zürich and Geneva.

LECTURE III.—JANUARY 27.—Methods of distributing energy—Distribution by shafting—Telodynamic transmission—Installation at Schaffhausen, Bellegarde, and Gokak—Practical defects of the system.

LECTURE IV.—FEBRUARY 3.—Hydraulic distribution of power—History of hydraulic transmission —Combination of water and power supply—Conditions of efficiency—Limitations—London system—Motors for hydraulic systems.

LECTURE V.—FEBRUARY 10.—Transmission of power by compressed air — History of the Paris scheme—Action of compressor main and motor—Reasons of low efficiency—The new Paris station—Advantages of compressed air—Applicability to long-distance transmission—Distribution of power by gas, by steam, and by superheated water.

LECTURE VI.—FEBRUARY 17.—Distribution of mechanical energy by electricity—Systems hitherto adopted—Examples of distribution of motive power electrically—Hersthal installation—Niagara scheme —Advantages of combined schemes — Heat and power—Light and power—Water supply, light, and power.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 9 ... Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. A. G. Green, "Qualitative Analysis of Colouring Matters." 2. Dr. B. Dyer, "The Proportion of Free Fatty Acids in Oil Cakes." 3. Mr Watson Smith, "Further Notes on Nitrous Oxide."

Surveyors, 12, Great George-street, S.W., 8 p.m. 1. Mr. P. D. Tuckett, "A Short Explanation of the Proposed Bimetallism as affecting British Interests." 2. Mr. A. Goddard, "The Currency Question and Land."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Andrew N. Prentice, "Notes of Tours made during the Last Two Years in Spain and the Island of Majorca."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. G. Du Maurier, "Social Pictorial Satire."

TUESDAY, JAN. 10...Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. Emerson Dowson, "Gas-Power for Electric Lighting."

Photographic, 5A, Pall-mall East, S.W., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Dr. Andrew Dunlop, "A Contribution to the Ethnology of Jersey." 2. Miss A. W. Buckland, "Points of Contact between Old World Myths and Customs and the Navajo Myth, entitled 'The Mountain Chant.'"

Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m.

Colonial Inst., Whitehall Rooms, Whitehall-place, S.W., 8 p.m. Mr. F. P. de Labilliere, "British Federalism: its Rise and Progress."

WEDNESDAY, JAN. 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. Mr. R. Bowdler Sharpe, "Curiosities of Bird Life." (Lecture II.)

Meteorological, 25, Great George-street, S.W., 7 p.m.

Geological, Burlington-house, W., 8 p.m. 1. Miss Raisin, "Variolite of the Lleyn and associated Volcanic Rocks." 2. Mr. Hamilton Emmons, "The Petrography of the Island of Capraja."

THURSDAY, JAN. 12...Antiquaries, Burlington-house, W., 8 p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. Silvanus P. Thompson, "Electric Lighting." (Lecture I.—Generation of electric currents.)

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Dr. J. A. Fleming's paper, "Experimental Researches on Alternate-Current Transformers."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, JAN. 13...Civil Engineers, 25, Great George-street, S.W., 7½ p.m. (Students' Meeting.) Mr. Edwin Hulme, "Description of the Design and Construction of a Roadway Bridge over the River Cam."

Astronomical, Burlington-house, W., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m. Mr. F. W. Sanderson, "Upon Science Teaching."

SATURDAY, JAN. 14...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, JANUARY 13, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

JUVENILE LECTURES.

Mr. R. Bowdler Sharpe, LL.D., delivered the second of his course of Juvenile Lectures on "The Curiosities of Bird Life." He commenced by referring to the extinct monsters, such as the pterodactyl, which was neither bird nor reptile, and the archæopteryx, found in the lithographic stone of Solothurn, which exhibited the earliest form of bird. The extinct birds were found with teeth, which differentiated them from existing birds; they were also of gigantic size. A bird six feet high, which is now extinct, was found in the Island of Rodriguez by Leguat, who called it *Le Géant*, about 200 years ago. Attention was drawn to the rudimentary wings of these early birds, and a representation was given of the penguin, showing the flippers, which enabled it to fly under the water. The auk was then shown, a bird with a small wing, which is now extinct. The skin of the auk is worth £350, and an egg £300; only 70 of each are known to exist in the world. The lecturer then explained, by means of a map of the world, the geographical distribution of bird life, describing the distinctive characteristics of the six divisions of the earth. In spite of these marked divisions, there are some birds which may be called cosmopolitan, such as the barn-door owl and the osprey. Several of the British birds were varieties of European birds; thus the British and Continental examples of such a bird as the long-tailed titmouse differ from each other. Special attention was directed to such common British birds as the robin, the hedge sparrow, and the wren. There are only three kinds of robin in the world, and these are confined to European regions. Jenny Wren is really a tropical bird, and a survival of the times when the climate of these islands was tropical. The same may be said of the hedge sparrow. Of migratory birds, there are winter visitants as well as summer visitants. Even such common birds as the robin and the hedge sparrow migrate to the south. Some birds breed in the far north, so that their eggs have never been found, and then migrate to the south. A specimen of the grouse, which changes its plumage to assimilate itself to its surroundings, and to protect it from the hawk, was shown. The lecturer rapidly passed over the special characteristics of the divisions of the world other than European, referring to those varieties of humming birds that inhabit the snowy heights of South America.

The lecture was illustrated by a series of coloured lantern slides painted by Mr. Keuhlemans.

On the motion of the Chairman, the cordial thanks of the meeting were voted to Mr. Bowdler Sharpe for his interesting lectures.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Wednesday, 11th inst. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Braddon, K.C.M.G., Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, Sir George Hayter Chubb, Lord Alfred S. Churchill, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Prof. James Dewar, M.A., F.R.S., Sir Henry Doulton, Prof. C. Le Neve Foster, D.Sc., F.R.S., Sir Douglas Galton, K.C.B., D.C.L., F.R.S.. Walter H. Harris, John O'Connor, Sir Robert Rawlinson, K.C.B., Sir Owen Roberts, M.A., Sir Albert Rollit, M.P., LL.D., Sir Saul Samuel, K.C.M.G., C.B., with Sir Henry Trueman Wood, Secretary to the Royal Commission.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Monday, 9th inst. Present: Lord Alfred S. Churchill, in the chair; Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir George Hayter Chubb, Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Sir Henry Doulton, James Dredge, John O'Connor, Sir Owen Roberts, with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

Proceedings of the Society.

CANTOR LECTURES.

GENERATION OF LIGHT FROM COAL GAS.

By Vivian B. Lewes, F.I.C., F.C.S.,
Professor of Chemistry, Royal Naval College.

Lecture IV.—Delivered December 12, 1892.

With the last lecture I brought to a conclusion our theories as to the cause of luminosity in coal-gas flames, and to-night I desire to discuss the question of the methods which we employ for the combustion of the gas, and how far these are in accordance with the theory.

As may easily be imagined, the first burner used for the consumption of coal gas was the end of the tube from which it was issuing, but Murdoch, the father of gas lighting, soon saw that the consumption was far too high, and the illuminating value far too low to make this a successful method of burning his new illuminant, and casting about to find a method of retarding the flow, he fitted an old thimble over the end of the pipe, and this happening to have several pin-holes in the crown, he lighted the gas escaping from them to prevent it escaping into the room, and at once found that several small jets gave a far better light than the one big flame, besides causing considerable economy in the consumption of gas. But as his experiments progressed, the form of his burner was modified, until in 1807, when fitting up the works of Messrs. Philips and Lee, in Manchester, he used two forms of burners—the one a rough Argand, and the other "a small curved tube with a conical end, having three circular apertures or perforations, about a thirtieth of an inch in diameter, one at the point of the cone, and two lateral ones, through which the gas issuing formed three divergent jets of flame, somewhat like a *fleur-de-lys*." The latter burner, which, from the shape of the jet, received the name of the "cockspur" burner, gave a light equal to 2¼ mould candles of six to the pound, while the Argands used developed a light equal to four candles of the same description. The Argand burner had been in use for the consumption of oils for some years before the introduction of coal gas, and in its early form consisted simply of two concentric tubes fixed at the required distance apart, the coal gas being fed in between them. Soon, however, the idea arose of closing the open circular slot by a metal ring pierced with holes, so as to give a circle of small jets; and even prior to 1816, the main principles of our present Argands were found to be in the burners in use. It was about 1816 also that the cockspur burner became converted into the cockscomb and then the batswing—thus marking a distinct advance in the method of burning the gas, as by spreading the flame out into a thin sheet instead of having it in a solid mass as in the jet burner; the air was more uniformly and readily supplied to the burning gas, and the increased temperature of the flame, due to the more perfect combustion, increased the light-giving power of the burner to nearly that of the Argands then in use.

In 1820, Neilson, of Glasgow, whose name will always be remembered as the discoverer of the hot blast in iron smelting, found that, by allowing two flames to impinge upon each other, an increase in luminosity was obtained; and, after several preliminary stages, the union jet, or fishtail jet, was produced, in which two holes, bored at the necessary angle in the same nipple, caused two jets of gas to impinge upon one another, so that they mutually splayed themselves out into a flat flame. The shape of the batswing flame was a very wide flame, of but little height, while the fishtail was much higher and narrower; and, although the service yielded by the fishtail for each foot of gas consumed was no better than, if it were as good as, that given by the batswing, yet its shape, which made it less affected by draughts, and enabled a globe to be used with it, ensured a greater mead of success for it than the batswing burner had secured.

The next 20 years was a period of gradual improvement and perfecting of the Argand and flat-flame burners—the influence of pressure and regulation of the flow of gas to the burner being gradually realised and arranged for—whilst other structural improvements were introduced.

On the 20th of May, 1853, Dr. Frankland, whilst giving one of the Friday lectures at the Royal Institution, showed, but did not fully describe, an Argand burner, in which the idea was first adopted of utilising heat, which otherwise would have been lost, to raise the temperature of the air supply; and this burner was afterwards described in Ure's Dictionary, the article, however, only being published a year or more after it had been written.

In speaking of this, Dr. Frankland says:—

"One of the conditions necessary for the production of the maximum illuminating power from a ga

flame is the attainment of the highest possible temperature; but this condition has been almost entirely neglected in the burners hitherto in use. I have, however, experimentally proved that it may be easily secured by employing the waste heat radiating from a gas flame for heating the air in which the gas burns, and that the increased temperature thus obtained has the effect of greatly increasing the illuminating power of a given volume of the gas."

The burner consisted of an ordinary Argand, but, in addition to the usual chimney, it had a second external one, which extended some distance below the first, and was closed at the bottom by a glass plate, fitted air-tight to the pillar carrying the burner, so that the air needed to support the combustion of the gas had to pass down the annular space between the two chimneys, and in its passage became highly heated, partly by contact with the hot inner glass, and partly by radiation.

The temperature of the air finally entering the burner, Dr. Frankland considered to be about 500° F., and he says:—

"The passage of this heated air over the upper portion of the Argand burner also raises the temperature of the gas considerably before it issues from the burner. Thus the gases taking part in the combustion are highly heated before inflammation, and the temperature of the flame is consequently elevated in a corresponding degree. Experiments with this burner prove a great increase in light, due chiefly to the higher temperature of the flame, but also partly due to the decomposition of marsh gas, which renders the latter a contributor to the total illuminating effect, whilst it merely performs the functions of a diluent when burnt in the ordinary manner. The following are the results of my experiments with this burner:—

	Ratio of Consumption per hour.	Light in Sperm Candles, each burning 120 grains per hour.
	Cubic Feet.	Candles.
1. Argand burner without external cylinder........	3·3	13
	3·7	15·5
	4·2	17·0
2. Same burner with external cylinder.	2·2	13·0
	2·6	15·5
	2·7	16·7
	3·0	19·7
	3·3	21·7

These results show that the new burner, when compared with the ordinary Argand, saves on an average 49 per cent. of gas, when yielding an equal amount of light, and also that it produces a gain of 67 per cent. in light with an equal consumption of gas."

In 1854, the Rev. W. R. Bowditch brought out a burner identical in nearly every respect with the above; and as this was brought prominently forward, it attracted considerable attention, with the result that the inception of the regenerative burner has been generally ascribed to Bowditch, whilst that honour is undoubtedly due to Frankland.

In speaking of the Bowditch lamp, "Owen Merriman," in an excellent series of articles on gas-burners, old and new, published in the *Journal of Gas Lighting*, says:—

"This burner contained many defects. Amongst others, the inner chimney could not long withstand the intense heat to which it was subjected, and, in consequence, had to be frequently renewed, the heating of the air was not effected solely by the products of combustion, but perhaps in a greater degree by the abstraction of heat from the flame itself, while at best this heating was but partial. Yet, these defects notwithstanding, the burner showed very clearly the beneficial results attending even a partial application of the principle, as, in the illuminating power it developed from the gas consumed, a clear gain of 67 per cent. over the Argand burner was obtained. Although the drawbacks connected with the construction of Mr. Bowditch's burner prevented its ever receiving general, or even extensive, adoption, its simplicity has gained for it the distinction of being freely copied by so-called inventors of a later day."

Dr. Frankland used his lamp in his study for fifteen years, until, he says, "it was superseded by a paraffin oil lamp."

In 1879, Fredrich Siemens, of Dresden, brought out his big burner, which, although one of the most effective, was also one of the most unsightly from its big overhead feed-pipe. This burner was really first made for heating purposes, but the light it gave was so far ahead of any effect which had been obtained up to that time, that, with certain modifications, it was adopted for lighting purposes.

In 1881, Mr. Thwaites published, in the *English Mechanic*, a description of an overhead recuperative burner, under the name of the "Hygienic lamp," and from that time up to the present, regenerative burners—good, bad, and indifferent—have increased and multiplied with great rapidity, the chief differences between them being in their names and slight details of design.

About the same time that the regenerative burner was struggling into prominence, Mr. Lewis brought out a burner in which the coal gas was consumed mixed with air, as in a Bunsen burner, and the flame was then urged by an artificial blast, against a cone of fine platinum wire, which, being heated to in-

candescence, gave a very high candle-power per cubic foot of gas consumed, and was thus the forerunner of the Welsbach, Clamond, and other incandescent lights.

Having traced the gradual genesis of our present burners, we must now see how the burners comply with the theories I have laid before you.

There are two special points to be observed in order to produce a luminous flame. Firstly, to use a hydrocarbon that is easily converted into acetylene by means of heat; and, secondly, to have as hot a flame as possible. These two conditions now pointed out by theory, have long been known in practice, gas managers realising that the larger the quantity of olefines, &c., in their gas, the better its candle power, and burner makers have discovered that the regenerative burner gives by far the best results per cubic foot of gas consumed.

But why then, it may be asked, does high-temperature retorting give such a poor gas, containing only a trace of acetylene. The reason is that acetylene heated to a high temperature insufficient to decompose it, polymerises into bodies such as benzene, naphthalene, &c., which go to make the tar better at the expense of the gas. In fact, by passing coal gas through a heated platinum tube, I have been able to obtain naphthalene in considerable quantity, and at the same time the gas has deteriorated, so you see that superheating the gas itself during manufacture can only end in failure.

But supposing it were possible to charge our gas with acetylene, it is so soluble in water or glycerine that it would all be absorbed in the gasholder and meters, and very little would come into the flame.

So we find that we must depend upon the gas flame itself for the production of acetylene; the luminosity of the flame results from having the acetylene formed in just the right place to be split up by the greater heat it encounters in passing up the flame. A mixture of hydrogen and 3 per cent. acetylene burns with very little greater luminosity than a mixture of 3 per cent. ethylene and hydrogen, simply because by the time the temperature of the flame is high enough to decompose it, a large amount has been burnt up.

We have two methods of raising the illuminating power of the gas, either by increasing the amount of acetylene-forming gases — which is expensive — or by regeneration. Regeneration acts in two ways —firstly, by increasing the initial temperature of the flame, as then we have the blue zone decreased in size because the temperature necessary to split up the acetylene is reached sooner, and therefore less is burnt without decomposition, also the higher the temperature, the more marsh gas is converted into acetylene. Secondly, the inert nitrogen of the atmosphere being at a high temperature to start with, abstracts less heat from the flame, and therefore the carbon particles are heated to a higher state of incandescence.

Through the kindness of Mr. Siemens, I have been enabled to measure the effect of regeneration on a flat flame.

The flame, when cold, had an area of 11 square inches, the luminous portions of which occupied 7·8 square inches, and the non-luminous 3·2 square inches. On regenerating this flame, the area decreased to 10·2 square inches, but the luminous zone occupied 7·9 square inches, whilst the non-luminous zone only occupied 2·5 square inches, the illuminating effect being more than doubled.

But regenerative gas burners, on account of their initial cost, are but little used—at any rate, for domestic purposes—and the flat-flame burner is still the popular one. By the use of even the improved forms of flat-flame burners, a great deal of the possible illuminating effect of the gas is lost, and the problem is, how may those burners be improved? And you will pardon my spending a few moments in pointing out the direction in which it seems possible to accomplish this.

When the gas issues from the jet, the hydrogen and marsh gas, having the least density, diffuse outward, and burn, the olefiant gas not diffusing so rapidly; but the larger the non-luminous zone, the greater the loss of unsaturated hydrocarbons; so that if we can by any means decrease the size of the blue zone, we not only gain a larger luminous zone, but also more particles of carbon.

About 35 years ago, a method of increasing the luminosity of a flat flame, called "Scholl's platinum light perfector," was introduced. It consisted of a thin strip of platinum, fixed across the burner between the orifices of the jet, so that the two streams of gas impinged upon it. The explanation given of its action was, that it broke the rush of gas, and so brought about more perfect combustion. While the burner was new, it did undoubtedly improve the illuminating effect, but, after a certain time, it fell off considerably, which would not have been the case had the effect been purely mechanical. Platinum has the

property—together with one or two other rare metals—of condensing gases on its surface, and making them, to a certain extent, more active chemically. For instance, if a piece of platinum wire be held in a gas flame, then the gas turned off, the platinum allowed to cool, and the gas turned on again, the wire will become red-hot, owing to the combination of the oxygen and hydrogen that have been condensed on its surface, and the temperature will often rise high enough to re-ignite the flame.

This action no doubt took place in the perfector, thereby adding to the heat in the non-luminous portion of the flame and thus reducing its size, and that the increase in luminosity was due to this cause is shown by the fact of its deterioration after it had been used a short time, as the carbide of platinum formed by the hydrocarbons attacking the platinum has not the property of condensing gases, and it is this formation of carbide of platinum which has prevented platinum incandescent lamps from becoming a success.

By placing a platinum wire in the non-luminous portion of the flame, taking care not to distort it, we can make that portion of the flame smaller in size, the platinum acting in the same maaner as in the perfector. The non-luminous portion of the flame may be reduced in another way, that is by increasing the rate of combustion at the base of the flame and thereby increasing the temperature. This was done by Sir James Douglass with his multiple Argand, in which a number of flames burnt one within the other, and by means of deflectors a current of air was made to impinge upon the outer flames at their base; by this means, though very little light was obtained from the outer flame, the inner ones were intensely heated and the candle-power of the gas per cubic foot doubled. Another example is to be found in Sugg's "London" Argand, and a gas which gave over 16-candle power when burnt in this Argand gave only 14-candle power when burnt in some old standard Argand burners which I tested, and in which the air supply was less perfectly arranged.

The most successful attempt probably yet made to increase the illuminating power of flat flames was in arranging two separate burners at such an angle to each other that the flames impinged and gave a luminosity considerably in excess of that given by the two flames when burning apart. This is caused by the fact that part of the heat radiated from one flame is utilised in heating the other, and also by an up-current being formed at the base of the flame you get the temperature rising more rapidly. The best of these burners are made with the two nipples fixed in separate tubes, so that air can be sucked up between the base of the flames, and those forms in which the nipples are screwed into a flat base do not give such good results, as the air current at the base of the flame is checked, and it is only reciprocal heating which comes into play.

This principle is also made use of in the cluster burners now so extensively used for street lighting, and in these again it is increased air current and increased temperature which leads to increase in luminosity.

My own impression is, that the direction in which to seek for an increase of luminosity in the flat flame is to make it appreciably thicker, and by some convenient arrangement to bring a fairly brisk air-current against the flat of the base of the flame. This is of course not easy to do, as you have not an up-draught as in the case of the Argand and glass to suck the air in, and if the current were to impinge on the bottom instead of the flat of the flame the loss of light due to distortion of the flame would be equal to, if no greater than, the increase due to heightened temperature. It is manifest from the facts I have brought before you that most of the improvements in our more ordinary burners have been in the direction of "fitting" the burner to the gas, and with any alteration in the quality and illuminating value of the gas, it is also necessary to consider and prove by experiment the best form of burner to obtain from it the highest service.

With an ordinary 16-candle coal gas, it is well known that, amongst simple burners, the London Argand gives the best results, but as the illuminating value of the gas increases, this burner ceases to supply air to the flame in sufficient quantity to give the highest service; and with a 20-candle gas we are driven back to a large flat-flame burner; and as the per-centage of heavy hydrocarbons in the gas increases in quantity, we have to use flat flames of diminishing size, so that with a rich 60-candle oil gas we get the best results with a 00 burner, and if we used a No. 2 we should have a smoky flame of much lower illuminating value.

If a rich oil gas be taken, and a certain percentage of oxygen be added to it, this helps the combustion, and we can burn the mixture at a larger burner than could be used without the oxygen, and in this way, by decreasing the cooling influence of the small burner, we

get an increase of luminosity which will, in some cases, amount to as much as 25 per cent.; but if we now take this oxy-oil gas and attempt to enrich a poor coal gas by mixing the two together, we at once find that the mixture has a lower illuminating value than if oil gas without oxygen had been used for enrichment, as the amount of hydrocarbons has been reduced to the limit at which the burners themselves can insure sufficient air being obtained by the gas for proper combustion, and the added oxygen lessens rather than increases the result.

Last October, a very interesting series of experiments were communicated by Mr. A. E. Forstall to the American Gas-light Association, as to the best burner to use with enriched coal gas of a value of 22 candles. He found that for a small consumption of gas the best results were obtained with one of Mr. Sugg's No. 6 table-top governor burners.

In my own mind, I must say the most important reform that can be made in gas-lighting is that the gas companies, or other properly qualified authority, should look after the burners in common use amongst their consumers, as the waste of gas due to improper methods of consumption is no gain to the gas company, and is an enormous loss to the consumer, who, in most cases, might obtain double the light he now enjoys at the same cost.

An important question which is constantly before the mind of the gas engineer is, "How far is it possible to go in the generation of light from coal gas, and what is the utmost limit that we are ever likely to attain?"

If we consider this question from the point of view of generating light by the incandescent particles present in the gas itself, we shall find that the regenerative principle is the only road open, unless we can command a supply of free oxygen, and that in the use of regenerative lamps we are tied by the destructibility of the material used in the construction of the lamp. Although it is possible to make a large regenerative burner which shall give a duty of 16 to 17 candles per cubic foot of gas consumed, such a lamp would only last a few hours, and practical experience has shown our lamp makers that the best results obtainable are those which give no more than about 10 candles per cubic foot of gas consumed, but at the same time give lengthened life to the lamp. In fact, our present regenerative burners probably represent the maximum luminosity to be obtained, together with durability of the material at our command, and if greater service is to be obtained from the gas, it can only be got by the use of more refractory material, and even then considerable trouble is sure to arise from the deposition of carbon in the gas supply pipes.

In the generation of light from coal gas only a comparatively small amount of the heat generated by the combustion is converted into light, but a large excess of heat is necessary to complete the actions culminating in the separation of the carbon particles, and any alteration in the composition of illuminating gas which increases the thermal value of the flame without destruction of the thermal particles, will increase its luminosity, and this, I believe, is the cause of some diluents in coal gas being of greater value than others, and affecting the amount of light emitted by the flame less than others; for instance, the work of Dr. Percy Frankland, and my own work of recent date, shows conclusively that methane is the most valuable gas to use for diluting heavier hydrocarbons, whilst hydrogen is far preferable to carbon monoxide.

This latter result has been questioned by some of the apostles of water gas, but I think the following experiments conclusively prove the fact. In these, known mixtures of hydrogen and oil gas were made. The hydrogen used contained 99·6 per cent. of the gas, and the oil was first put into the test holders and the hydrogen then added, every precaution being taken to ensure mixing.

SET I.

Illuminating value of the original oil gas ...... 49·6 candles.

Per-centage of hydrogen.	Per-centage of oil gas.	Illuminating Value of the Mixture.	
		Found.	Calculated.
33·3	66·6	34·2	33·0
50·0	50·0	25·5	24·8
66·6	33·3	18·2	16·5

SET II.

Illuminating value of the original oil gas ...... 42·8 candles.

Per-centage of hydrogen	Per-centage of oil gas.	Illuminating Value of the Mixture.	
		Found.	Calculated.
25·0	75·0	32·8	32·1
50·0	50·0	23·9	21·4
60·0	40·0	21·0	17·1
66·6	33·3	12·4	14·2
71·4	28·5	9·0	12·2

These experiments show that, with hydrogen gas, the illuminating value of the mixture is higher than one would expect from calculation for candle-powers higher than 18, but that, when diluted below that value, the excessive dilution causes a loss of illuminating power, and so necessitates a larger addition of the enriching gas than that calculated.

Some years ago Dr. Percy Frankland read a paper before the Chemical Society upon ethylene, and his figures reveal the same fact:—

Illuminating value of the ethylene ...... 65·5 candles.

Per-centage of ethylene.	Per-centage of hydrogen.	Illuminating Value of the Mixture.	
		Found.	Calculated.
77·55	22·45	54·58	54·28
68·39	31·61	49·37	47·87
53·58	46·42	39·21	37·50
35·47	64·53	30·85	24·82
26·08	73·92	22·84	18·25
13·37	86·63	6·73	9·35

The next combustible diluent experimented with was carbon monoxide, which has an interest for us not only as being the cheapest combustible gas, but also the most poisonous, the numerous accidents which have arisen from the use of water gas being due to its presence.

Illuminating value of the original oil gas ...... 54·7 candles.

Per-centage of carbon monoxide.	Per-centage of oil gas.	Illuminating Value of the Mixture.	
		Found.	Calculated.
90	10	unreadable	5·4
75	25	8·94	13·6
50	50	21·50	27·3
25	75	38·40	41·0

These experiments show that when even only a small per-centage of carbon monoxide is used, it has a tendency to reduce the illuminating value of the mixture, whilst in order to make a 17 or 18 candle-power gas with carbon monoxide as the basis, a very large excess of hydrocarbon gas would have to be used.

In Frankland's experiments with carbon monoxide and ethylene, the results obtained were:—

Illuminating value of the original ethylene ...... 68·5 candles.

Per-centage of carbon monoxide.	Per-centage of ethylene.	Illuminating Value of the Mixture.	
		Found.	Calculated.
18·35	81·65	55·27	55·93
32·25	67·75	47·73	46·40
53·70	46·30	33·09	31·71
62·06	37·94	26·52	25·97
71·27	28·73	13·26	19·64
76·11	23·89	6·56	15·86
80·00	20·00	0·00	13·70

Showing an even greater loss of illuminating value in the more diluted mixtures.

Having seen that admixture with hydrogen gives higher results than would be expected, whilst the carbon monoxide seriously detracts from the illuminating value, it might be expected that with water gas—a mixture of the two, theoretically in nearly equal proportions—the one would neutralise the other, and that the results obtained would be nearly proportional to the amount of oil gas used. Experiment, however, shows this not to be the case, the loss in illuminating value being as great as with the carbon monoxide alone.

Illuminating value of the original oil-gas ...... 54·7 candles.

Per-centage of water-gas.	Per-centage of oil-gas.	Illuminating Value of the Mixture.	
		Found.	Calculated.
90	10	unreadable	5·4
75	25	11·9	13·6
50	30	21·6	27·3
25	75	35·6	41·0

These experiments not only show the fallacy of supposing that it is possible to calculate the amount of enriching gas, which it is necessary to add in order to attain a given illuminating value, without first taking into consideration the composition of the gas to be enriched, but also give interesting information on the important subject of the carburetting of non-luminous gases.

The varying effect exercised upon the enriching gases by the different diluents, is not due to one cause only but to several acting in unison. In the first place the illuminating power of a flame is to a great extent governed by temperature. The hotter the flame the more readily are the hydrocarbons broken down

and carbon liberated, and the light which this emits being entirely governed by temperature, the hottest flame will always give the most light from any given quantity of hydrocarbons. If we take two flames of equal size, the one obtained by burning hydrogen, and the other carbon monoxide, it will always be found that the former is the hottest. Taking a jet of hydrogen, three inches in height, and a similar one of carbon monoxide, and testing their temperature with a Le Chatelier thermo-couple, the hydrogen flame was found to have a temperature of 1,488° C., or 2,610° Fahr., whilst a carbon monoxide flame of the same size gave a temperature of 1,419° C., or 2,554° Fahr.

Another cause is, however, I think to be found in the fact that as a carburetted carbon monoxide flame burns, a large proportion of carbon dioxode is produced and drawn into the flame, and this in the luminous zone of the flame attacks the liberated carbon, combining with it to form carbon monoxide again, and so uses up some of the carbon upon the presence of which luminosity depends, whilst the high specific heat of the carbon dioxide tends to cool the flame.

The cause of the increased effect produced by enrichment upon a poor coal gas is to a great extent the methane, which forms a very large proportion of the saturated hydrocarbons, and which, although it is practically non-luminous when burnt alone, yet adds considerably to the luminosity of a mixture, also to the hydrogen, more than 50 per cent. of which is present, and which increases the temperature, and by so doing, the luminosity also, whilst carbon monoxide is only present in coal gas in quantities varying from 3 to 8 per cent., so that its effect upon the luminosity of the flame is entirely overshadowed by the increase due to hydrogen and methane.

Another cause which affects the amount of light emitted by a flame to a greater extent than has ever been fully recognised, is the condition of the atmosphere in which it is burning.

Mr. John Methven, some years ago, found that over a long series of experiments, and with the temperature practically constant, candles gave, per 120 grains of sperm consumed, a light equal to 1·104 as compared with a light of constant power—Methven screen—and that this was increased to 1·196 candles when the air in which the candles were burning was dried. This difference in the light value he considered to be due entirely to the removal of moisture, as the temperature remained the same.

He also found that when dried air was supplied to a flame the amount of light emitted was practically constant, but when air saturated at increasing temperatures is supplied, the light value is rapidly dimished, so that between the temperature of 50° F. and 75° F. a diminution of 10 per cent. takes place in the light emitted by an Argand flame burning five cubic feet of gas per hour, whilst with a flat flame a reduction of 11·2 per cent. took place, and with a gas flame from a 2-candle burner a loss of 13 per cent. was found within the same range of temperature. The greater loss observed with the flat flame and the small jet, Mr. Methven ascribes to the power of the different flames to battle with the aqueous vapour.

These experiments were made by passing air from a gas-holder through a leaden chamber over the surface of sulphuric acid to dry it, whilst to saturate it the sulphuric acid was replaced by water. At the end of the chamber was an upright tower, on the top of which the flame was burning, surrounded in the case of the 2-candle burner by a lamp chimney, and the flat flame by a glass globe.

I have repeated Mr. Methven's experiments in a rather different way, in order, as far as possible, to eliminate any disturbing factors.

I used an open bar photometer, fitted with the burners and disc 14 inches above the level of the table, and cylinders of thin glass, 12 inches in diameter and 24 inches high, were specially made by Messrs. Powell. The tubes carrying the burners rose straight from the photometer table, and carried sliding collars, with four arms to support the glass cylinders. Flat perforated zinc boxes were made to fit into the cylinders, exactly an inch in depth, and were surrounded with soft felt, so as to prevent any air passing up between the cylinder and box; and these boxes, having been completely filled with dry or wet pumice or calcic chloride, as the case may be, the material having been previously sifted to pass through a 3-8th mesh, but not a 1-8th, will each give very nearly the same amount of obstruction to the passage of the air; whilst, to prevent air entering the top of the cylinder, and to quickly remove the products of combustion, a zinc plate was fitted over each cylinder, with a two-inch tube, with funnel mouth descending to within a short distance of the top of the flame.

Working with this apparatus, I found, as the mean of many hundred experiments, that a flame, having an illuminating value of one candle, had its light diminished by 8 per cent.,

when the amount of water vapour present in the atmosphere increased one grain per cubic foot; whilst, under the same conditions, a 10-candle flame was only affected to the extent of 3·8 per cent., and a 16-candle flame still less.

This being so, it is manifest that, if the illuminating value of a 10-candle flame is being tested against a candle on a day when the air is dry, the one candle will be doing its best, and the illuminating value of the 10-candle flame will appear lower, than on a day when there is a larger amount of humidity in the air, which, by affecting the small flame more than the large, gives the latter a considerable advantage.

To try how far this showed in actual working, a long series of experiments were made with Mr. Harcourt's one-candle Pentane flame against a constant 10-candle standard, both large and small flames, having the air supplied to them dry, normal, or wet, as the case might be. The results are given below:—

	Normal.	Wet.	Dry.
Illuminating value of flame ..	9·95	10·44	9·49
Per-centage of saturation	54	66	33
Grains of water per cubic foot of air	7·3	8·0	5·7
Temperature 2 inches below the 10-candle flame	87	85·8	97·5

Showing a variation of ·95 candle for a difference of 2·3 grains of moisture per cubic foot of air, which is equal to an increase in illuminating value of 3·96 per cent. per grain of moisture in the cubic foot of air.

It will, however, be seen that while the temperature in the cylinder is but little higher with dry pumice in the box than with wet pumice, it is 10° higher when the box is filled with calcic chloride.

It was thought that perhaps this alteration in temperature might be due to alteration in the flow of air through the cylinder, and that the secret of variation of luminosity might be in this. To decide this point a delicate anemometer was fitted to the exit tube, and on making the rate of flow identical in each case, the same difference in illuminating power was observed. It was then thought possible that the alteration of the temperature, from whatever cause it arose, might be influencing the amount of light emitted, and instead of the large glass cylinder, a small chamber four feet square was constructed to hold a standard burner, the light of which could pass through thin glass windows in on to the photometer disc, and although no appreciable alteration in temperature could be observed when wet or dry air was used, the alteration in the light emitted remained.

Finally the temperature of the flame burning in normal wet and dry air was taken by the Le Chatelier thermo-couple, and it was found that an increase of one grain in the amount of moisture present lowered the temperature of the flame itself nearly 100°, and it is the diminution in the incandescence of the matter in the flame, due to the heat used up in the physical and chemical changes brought about in the flame by the water vapour, which reduces the amount of light emitted.

Dr. Bunte has also made a series of experiments upon the effect of carbon dioxide in air upon the light emitted by flames, and finds that carbonic acid alone may be introduced to a considerable extent without producing any very great effect; but that, when a flame is burnt in a closed chamber, so that the per-centage of vapour increases with the carbon dioxide, and the per-centage of oxygen is diminished at the same time, then the action upon the flame becomes very marked:—

	Carbonic acid in air. per cent.	Illuminating power in per cent. of original power in normal atmosphere.	Diminution of power in per cent. of original power in normal atmosphere.
Batswing:—			
1	0·26	94·3	5·7
2	0·41	90·6	9·4
3	0·49	87·5	12·5
4	0·54	85·0	15·0
5	0·60	81·7	18·3
6	0·65	80·0	20·0
Argand:—			
1	0·18	96·5	3·5
2	0·25	93·7	6·3
3	0·37	84·5	15·5
4	0·43	82·8	17·2
5	0·56	79·7	20·3
6	0·68	77·3	22·7

Results which teach us that proper ventilation is as essential to those processes of combustion which give us light, as to the still

more marvellous phases of slow combustion which we call life.

Dr. Bunte, however, comes to the conclusion that the effect of water vapour in air upon the flame is relatively small, a conclusion which the work I have brought before you certainly disproves.

The effect of inert gases upon the luminosity of flame may be looked upon partly as one of dilution, and therefore reduction of the quantity of oxygen present in the air in which the flame is burning, and partly cooling of the flame, by physical and chemical actions taking place when the water vapour or carbon dioxide is drawn into the flame itself.

An idea of the extent of this may be obtained by studying the effect of various diluents upon coal gas, burnt in a form of burner in which the flow of coal gas and diluent could be accurately controlled.

Volumes of Gases required to render 1 volume of Coal Gas Non-luminous.

One volume of gas requires—

0·5	volumes of	oxygen.
1·26	,,	carbon dioxide.
2·27	,,	air.
2·30	,,	nitrogen.
5·11	,,	carbon monoxide.
12·4	,,	hydrogen.

Showing that a diluent which burns and adds to the general temperature of the flame must be added in far greater quantity than an inert and non-combustible diluent such as nitrogen, a result fully borne out by experience.

Some observers have attributed the varying effect of diluents to the effect of density, but the destruction of luminosity in a flame can be brought about by cooling as well as by dilution.

It is evident that this being the case, if one diluent has the power of abstracting more heat from the flame than another, it will be more active in reducing the luminosity, and a smaller quantity will be required to render the flame non-luminous. And on comparing the specific heats of equal volumes of the diluents used in the last experiment, the reason for the small quantity of carbon dioxide is at once seen.

Specific Heats of Equal Volumes.

Oxygen	0·2405
Carbon dioxide	0·3307
Nitrogen	0·2370
Air	0·2374
Carbon monoxide	0·2370
Hydrogen	0·2359

If this be the true explanation, then it should be easy to trace the action by the decrease in temperature of the flame when carbon dioxide is used to render it non-luminous.

In order to take the temperature of the inner cone of the flame by means of the thermo-couple before described, it is manifest that the wires, even when protected by glass, must not pass through the outer zone, as with some mixtures of coal gas and air the heated platinum would set up rapid combination on its surface. To overcome this difficulty the wires, insulated with glass, were passed up the interior of the burner tube, and the gas supply was kept constant at 6 cubic feet per hour, whilst the diluents were supplied under pressure at the same rates as before determined, and the following results were obtained:—

Temperature of Flame from Bunsen Burner, with Consumption of 6 cubic feet of Coal-Gas per Hour.

Point in Flame.	Flame Rendered Non-luminous by			Luminous Flame from Bunsen.
	Air.	Nitrogen.	Carbon Dioxide.	
	Deg.	Deg.	Deg.	Deg.
½-inch above burner	54	30	35	135
1½-inch above burner	175	111	70	421
Tip of inner cone	1,090	444	393	913
Centre of outer cone	1,533	999	770	1,328
Tip of outer cone	1,175	1,151	951	728
Side of outer cone level with tip of inner cone	1,333	1,236	970	1,236

Results which fully bear out the inferences derived from the behaviour of the flames in the former experiments. In the flames rendered non-luminous by diluents, the inner cone for the first 1½ inches is decidedly cooler than in the luminous flame, owing to the cooling action of the nitrogen or carbon dioxide, in the upper portion of the inner cone of the flame rendered non-luminous by air, however the oxygen of the air is acting, and the temperature is therefore higher than in the luminous flame, whilst in both the hottest portion of the flame is almost halfway between the tip of the inner and outer cones.

In flames rendered non-luminous by inert diluents, this is not the case, as the full amount of air necessary for combustion only being obtained at the side and tip of the outer cone, these are the hottest points.

The low temperature registered at the tip of a luminous flame is probably due to the impossibility of keeping that portion of the flame steady when the gas is burning from a Bunsen with the air-supply closed.

Experiments with a Bunsen, burning a mixture of air and coal gas in such proportions as to give the green inner cone, showed that although the excess of air caused a low temperature of the bottom of the inner cone, the increase in rapidity of oxidation due to excess of oxygen, caused a rapid rise of temperature, and a hotter and smaller flame was the result.

	Blue inner cone.	Greenish inner cone.
	deg.	deg.
Tip of inner cone	1,090	1,575
Centre of outer cone	1,533	1,630
Tip of outer cone	1,175	1,545
Side of outer cone level with the tip of inner cone	1,333	1,511

These experiments, as well as the researches of Heumann, show that oxidation, dilution, and cooling all help to bring about the destruction of the luminosity in a Bunsen flame.

I have now gone as far as the limited time at my disposal would admit, into the theories and facts which we can glean with regard to the luminous combustion of a coal-gas flame, and I must confess that my own feeling is one of disappointment at not having succeeded in crowding more into the four hours I have been privileged to be with you, and in concluding, can only hope that you will take the will for the deed, and if the performance has been poor, remember that the desire has been to do the fullest possible justice to the subject and the workers who have elucidated it.

Miscellaneous.

ENGINEERING CONGRESS AT CHICAGO EXHIBITION.

The President of the World's Congress Auxiliary has appointed a committee to make arrangements for a Conference on engineering education, as a part of the general engineering congresses to be held from July 31 to August 5. The scope of the Conference will include all matters relating to the course of instruction and equipment of institutions giving instruction in civil, electrical, mechanical, mining, municipal, military, and naval engineering, and in architecture. Steps have already been taken to secure papers from leading engineers.

The committee proposes, subject to amendment, the following list of subjects to be considered by the Conference:—

1. Present state of collegiate engineering education in the leading countries of the world, to include:—*a.* Historical outline as to origin, age, grade, and support of the schools and colleges giving engineering education. *b.* Qualifications for admittance. *c.* Courses of study in civil, electrical, mechanical, mining, military, municipal, and naval engineering, and in architecture. *d.* Equipment. *e.* Laboratory work and field practice.
2. The ideal engineering education.
3. Maximum and minimum mathematics necessary for an engineer.
4. Modern foreign languages in an engineering course of study.
5. Practical laboratory work and field practice.
6. Shop, laboratory, and field equipment.
7. Original research by students.
8. Best method of training engineering students in technical literary work.
9. Best methods of studying current technical literature.
10. Drawing for engineering students.
11. Number of hours per day, days per week, and weeks per year required in college work.
12. Vacation work.
13. Graduation theses.
14. Degrees conferred.
15. Present favourable and unfavourable tendencies in engineering education.
16. Views of practising engineers as to the needs of engineering education.
17. Comparison between American and European methods in engineering education.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

JANUARY 18.—BENNETT H. BROUGH, Assoc. R.S.M., F.G.S., "The Mining Industries of South Africa as shown at the Kimberley Exhibition."

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock:—

JANUARY 19.—J. BARR ROBERTSON, "The Currency Problem." Sir THEODORE CRACRAFT HOPE, K.C.S.I., C.I.E., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock:—

JANUARY 17.—EDWARD J. HOWELL, "Mexico Past and Present."

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday Evenings, at Eight o'clock:—

PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

LECTURE II.—JANUARY 20.—Water power—Increase of availability of water power if transmission is possible—Types of water motors—Governing of hydraulic motors—Cost of water power—Storage of power by reservoirs and accumulators—Systems at Zürich and Geneva.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 16...Cleveland Institute of Engineers, Middlesbrough, 7½ p.m.

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Charles Hose, "Journeys in Sarawak, Borneo."

British Architects, 9, Conduit-street, W., 8 p.m. 1. Address to Students by the President, Mr. J. MacVicar Anderson. 2. Critical Remarks in Student Work, by the Secretary.

Medical, 11, Chandos street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Prof. Hull, "Why the Ocean is Salt."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. E. L. S. Horsburgh, "The Spanish Armada."

TUESDAY, JAN. 17 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p m. (Foreign and Colonial Section.) Mr. Edward J. Howell, "Mexico, Past and Present."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Functious of the Cerebellum and the Elementary Principle of Psycho-Physiology." Lecture I.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. J. Emerson Dowson's paper, "Gas-Power for Electric Lighting." 2. Reception by the President and Council.

Asiatic, 22, Albemarle-street, W., 4 p.m.

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. David F. Schloss, "The Reorganisation of our Labour Department."

Pathological, 20, Hanover-square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. E. Y. Watson, "A proposed Classfication of the *Hesperiidæ*, with a Revision of the Genera." 2. Mr. E. E. Austen, "Descriptions of the new Species of Dipterous Insects of the Family *Syrphidæ* in the Collection of the British Museum, with Notes on the Species described by the late Francis Walker." 3. Mr. Gilbert C. Bourne, "Two new Species of Copepoda from Zanzibar."

WEDNESDAY, JAN. 18...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. Mr. Bennett H. Brough, "The Mining Industries of South Africa."

Meteorological, 25, Great George-street, S.W., 7½ p.m. Address by President (Dr. C. Theodore Williams), "The High Altitudes of Colorado and their Climates."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m. Presidential Address by Dr. R. Braithwaite.

Entomological, 11, Chandos-street, W., 7 p.m. Annual Meeting. Address by the President, Mr. F. D. Godman.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, JAN. 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) J. Barr Robertson. "The Currency Problem."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8 p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. W. Carruthers, "The Plants of Malanji collected by Mr. A. Whyte, and described by Messrs. Britten, Baker, and Rendle." 2. Mr. G. F. Scott Elliot, "Report on the District Traversed by the Anglo-French Sierra Leone Boundary Commission."

Chemical, Burlington-house, W., 8 p.m. 1. Prof. T. E. Thorpe, "The Determination of the Thermal Expansion of Liquids." 2. Prof. Thorpe and Mr. Lionel M. Jones, "The Thermal Expansion and Specific Volumes of certain Paraffins and Paraffin Derivatives." 3. Messrs. W. A. Tilden and Sidney Williamson, "The Hydrocarbons formed by Decomposition of the Citrene Dihydro-chlorides." 4. Messrs. F. S. Kipping and W. J. Pope, "Camphorsulphonic Derivatives." 5. Dr. Henry E. Armstrong, "Note on the Decaphanes formed from Terpenes and Camphor."

London Institution, Finsbury-circus, E.C., 6 p.m. Prof. Silvanus Thompson, "Electric Lighting." Lecture II.—Accessories and Meters.

Royal Institution, Albemarle-street, W., 3 p.m. Rev. Canon Ainger, "Tennyson." (Lecture I.)

Historical, 11, Chandos-street, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p m.

FRIDAY, JAN. 20 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Cawthorne Unwin (Howard Lecutres), "The Development and Transmission of Power from Central Stations." (Lecture II.)

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Dewar, "Liquid Atmospheric Air."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, JAN. 21 ... Royal Institution, Albemarle-street, W., 3 p.m. Prof. Hubert Parry, "Expression and Design in Music."

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FRIDAY, JANUARY 20, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

HOWARD LECTURES.

On Friday, 13th inst., Prof. W. Cawthorne Unwin, F.R.S., delivered the first lecture of his course on "The Development and Transmission of Power from Central Motors."

The lectures will be printed in the *Journal* during the summer recess.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a Prize of £20 for competition amongst students of the Schools of Art of the United Kingdom, at the annual National Competition held in 1893.

The Prize is offered to the student who obtains the highest awards in the following subjects :—

(*a*) A finished drawing of imperial size from the nude living model.

(*b*) A set of time studies from the nude living model (mounted on imperial size mounts).

(*c*) A set of studies of hands and feet from the living model (mounted on imperial size mounts).

(*d*) Drawing from the life done at the examination on May 11th, 1893.

No student will be eligible for the award who does not pass in the examination *(d)* in drawing from the life, and who does not obtain an award for *(a)* the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The drawings, &c., are to be submitted, with other school works, in the usual manner to the Department of Science and Art, in April, 1893. Each competing drawing must be marked, "In competition for the Mulready Prize," *in addition* to being labelled according to the regulations of the Department of Science and Art.

STOCK PRIZE.

For the Decoration of Part of the Interior of a Building.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a Prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the annual competition held in 1893.

The prize is offered for the best original designs for an Architectural Decoration, to be carried out in any or all of the following processes, *e.g.*, painting, stucco, carving, mosaic, or any other process.

This Architectural Decoration is to be either for the side of a room, or a hall, a ceiling, or the apse or side of the chancel of a church, or any suitable part of the interior of a building.

The designs must be on imperial sheets. Each set must consist at least of a coloured drawing to scale of the whole design of decoration, and two coloured drawings of details on separate imperial sheets. Mere patterns or sketches of details, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The designs must have been made during the previous school year.

The designs are to be submitted, with other school work, in the usual manner, to the Department of Science and Art, in April, 1893. Each of the imperial sheets, forming a set of competing designs, must be marked, "In competition for the Stock Prize," *in addition* to being labelled or staged according to the regulations of the Department of Science and Art.

Chicago Exhibition, 1893.

FINE ARTS COMMITTEE.

A meeting of the Committee on Fine Arts was held on Saturday, 14th inst. Present: Sir Frederick Leighton, Bart., P.R.A., in the chair; J. Macvicar Anderson, P.R.I.B.A., Wyke Bayliss, P.R.Soc.B.A., W. E. Lockhart, R.S.A., W. W. Ouless, R.A., Sir Henry Trueman Wood, Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

Proceedings of the Society.

INDIAN SECTION.

Friday, January 12, 1893; Major-Gen. Sir George Stewart White, K.C.B., V.C., in the chair.

The paper read was—

UPPER BURMA UNDER BRITISH RULE.

By Herbert Thirkell White,
I.C.S., C.I.E.

The annexation of Upper Burma at the close of the year 1885 added to the Indian Empire a country of about 120,000 square miles in area, with a scanty population of some 3,500,000. The physical features of this country need but brief notice. Through its whole length from north to south runs the great river Irrawaddy, the secret of whose source is among the few geographical problems still unsolved. In the height of the rains, it is a majestic flood; in the dry season, it is so shallow that flat-bottomed steamers with difficulty crawl over its sand-banks, and sometimes stick fast till the rise of the water releases them. Other waterways are the Chindwin and Mogaung, affluents of the Irrawaddy, the Sittang, and further east, in the Shan country, the Salween and the Mèkong, or Cambodia river. Of all these the navigation is rendered difficult and dangerous by shoals and rapids. Fertile plains and uplands occupy wide stretches in the valleys of the Irrawaddy and Sittang; but much of the country is covered with dense forests. North and west are ranges of hills, peopled by Kachins, Chins, and other savage races. On the east, the Shan country is a level table-land for many miles, becoming broken and hilly as it nears the Salween. The climate of Upper Burma is less unhealthy than is generally believed. The dry season is hot and dusty, but the winter months are cool and pleasant; while the normal rainfall is much less than in the delta districts of Lower Burma.

Some account of the people of the country is a necessary introduction to my subject. In Upper Burma, unaffected by foreign influences, the Burman character attained its natural development. Proud of their nationality, the Burmese regard the Chinese and Shans as their cousins; the savages of the hills, Karens, Kachins, and Chins, they class as wild men; all other races, European and Asiatic, they lump together as *kala*, a word which has the same meaning as the Greek βάρβαρος. Even in adversity they maintain a high bearing. The people of Mandalay, for instance, showed no signs of subjection by any submissive attitude when their city was filled with our troops. Even then one was jostled in the streets much as one is jostled in the streets of London. This pride of race is found among the highest and the lowest. The house of Alaungpaya, though a mere mushroom growth of a hundred years, was venerated with superstitious and servile devotion. But, subject to this exception, there is probably no country where the claims of birth were so little regarded. Save the throne itself, there was no dignity to which any Burman might not aspire. Nor did a man who had attained high place forget or despise his poor relations. A great Minister of State once brought to see me his brother, a peasant from the fields, who wore the scantiest garments, and squatted on the ground while his distinguished relative sat by clad in silk and gold. The genial good nature and kindheartedness of the Burmese are proverbial. Affection for their children is a charming feature in their character. I have often seen a constable come off a long turn of sentry go and at once march about with a child or two perched on his shoulders. Burmans of all classes frequently display unexpected humanity. Only a few weeks after the occupation of Mandalay, when the story of the king's fall was unknown or disbelieved except in the capital, and when no Burman dreamed that his country had been permanently conquered, two unlucky grass-cutters were wounded and captured by Burmese villagers in a brush with a small party of cavalry. A few days later a column, marching past the scene of the skirmish, received from the hands of the villagers the two *kalas*, who had been plastered and nursed, with rough humanity, by their captors. King Pagan, who fought us in the war of 1852, was immediately afterwards deposed by his brother, King Mindôn. Throughout Mindôn's reign of more than 25 years, ex-King Pagan lived in his own house; he survived his successor and at last died in his bed. Yet side by side with these amiable features we find at times in the same people traits of brutal ferocity. Dacoits, of whom more hereafter, perpetrated fiendish and indescribable barbarities, not on us, but on their own countrymen and countrywomen. The massacres which stained the opening of King Thebaw's reign

will be fresh in the memory of all. Though arrogant and boastful, the Burmese as a race cannot be credited with active courage or pluck. At a Burmese boxing match a champion will jump into the ring and dance about, smacking his breast and arms and cracking his fingers, challenging all comers. It is with much difficulty that any one can be induced to take up the challenge; but when a second champion appears, the challenger bolts like a hare if he thinks his opponent a shade taller or broader than himself. When at last the boxing does begin it is of the mildest description, and is stopped by the umpires at the first scratch. Yet street fights and riots are common enough, and knives are drawn and cudgels used on very slight provocation; while it is a commonplace with all writers on Burma that dacoity, that is robbery by organised gangs of armed men, is the national pastime which every lad of mettle takes up merely for the fun of the thing, a statement which I venture to think rests on insufficient grounds. Half-a-dozen robbers, armed only with sticks, will raise an alarm at dead of night and put to flight a whole village. But captured and pardoned dacoits have related to our officers that, when starting on a foray, their hearts have been as water for fear lest the prey should turn on them. At the least sign of resistance they were quite prepared to fly for their lives. So in real warfare, the Burman is not the man for a forlorn hope or a charge home; and in recent years the occasions on which Burmese troops have met us in the field are rare indeed. But in passive courage the Burman is not deficient. Half torn to pieces by a shell, he will die almost without a groan, asking only for an umbrella to keep off the sun. Condemned to death, he will walk calmly to the gallows; or half a dozen men will sit smoking and laughing as they are called up one by one to face the shooting party. Sincerely religious, the Burman is at the same time superstitious and credulous. He believes in *nats*, or good and evil spirits; in ghosts; in charms which will render him invulnerable; in charms which will win for him the lady of his heart. Worse than all, he swallows every idle tale told by any designing person who pretends to special sanctity, to supernatural powers, or to royal blood. Superstition and credulity die hard. In the hills there are still people who, in times of scarcity, transform themselves into man-eating tigers. The reputation of one noted dacoit leader, who pretended to be invulnerable, survived even the collapse which should have ensued when he was shot dead by our troops. His body was dug up, and parts of it were boiled down into an ointment which was used as a sovereign charm against lead or steel.* To pass to other matters, in his expenditure the Burman is prodigal to excess. If he makes money, he spends it on works of merit, the feeding of monks, the building of a pagoda, the construction of a bridge, an irrigation tank, or a road to the village monastery. He has no desire to hoard a fortune, or to found a family. Notable exceptions apart, I am not sure that gratitude is a prominent feature in the Burmese character. I have known cases in which venerable queens, reduced to indigence, have been supported by faithful retainers. But not one of his Ministers was willing to follow King Thebaw into exile; and it was with difficulty that the banished king and queen could keep Burmans for their personal service. One little girl among the queen's attendants at Ratnagiri caused some embarrassment by climbing up a tree like a monkey, and sitting there till she had extorted a promise that she should be sent home.

Of Burmese women much has been said and written. They live on terms of practical equality with their brothers and husbands, and in the management of the house and in business affairs their superiority is undisputed. When one sees and hears a band of girls laughing as they come from the village well, or chattering in the bazaar, one understands that in Burma the subjection of women is unknown. In unimportant details, however, the women are content to take the second place. A Burman out for a walk with his wife stalks a yard or two a head, his wife meekly following, and at public entertainments the men occupy the best seats. As a rule the men of the family dine first, waited on by the women. It has been related, as an indication of the extent to which Queen Supayalat ruled her husband, that she used to dine before him. But in all essential points Burmese women enjoy perfect freedom and a position far different from that of their Indian sisters. All the petty trade is in their hands, and the women of the middle-class know no greater pleasure than to have a stall in the bazaar, where they may sit half the day bargaining and gossiping with their friends. I remember half a dozen bazaar

* This happened in the Shan country, not in Burma proper.

women, present at an examination in a monastic school, mentally working out a Burmese version of the time-honoured question about a herring and a half for three halfpence, while their sons and the schoolmaster were attacking the problem with the aid of the Burmese equivalent for slates and pencils. In graver matters women play a leading part. That Queen Supayalat had much to say in the government of Upper Burma is well known. In a large town, immediately after the expedition to Mandalay, we found the mother of the local *Wun* or governor the chief personage in the place. At a Burmese country police-station I have been referred to the sergeant's wife as the authority in the sergeant's absence; and I believe there is at least one large village where the headman is a woman. Notwithstanding this well known capacity of women for affairs, we did not find it necessary to interfere with the ladies of the Burmese royal house, of whom numbers were, and still are, living in Mandalay in receipt of small pensions from our Government.

Of the religion of the Burmans, the basis of their national life, some mention must be made. And in dealing with this subject I find it necessary to somewhat anticipate the regular order of my remarks. The devotion of the people to the Buddhist religion is indicated by the countless sacred buildings with which the country is adorned. Every high place is crowned with a pagoda, every village has its monastery and its pilgrims' rest-house. Mandalay, the city of a king full of zeal for the faith, was crowded with monasteries, some remarkable for beauty of design and ornament. One of the most striking, though not the most beautiful as a work of art, was the monastery known as the "Incomparable," in recent months, alas! destroyed by fire. Near it stood a small pagoda surrounded by hundreds of little shrines, each covering an alabaster slab inscribed with a portion of the law. On Mandalay hill stood an upright image of Gaudama, with outstretched arm, as it were the Palladium of the city. At Pagan and elsewhere are thousands of pagodas, many in ruins, relics of the piety of bygone ages.

The monks, who are bound by vows of chastity and poverty, are the object of much veneration. Monastic vows are not irrevocable, and many Burmans of note are monks who have renounced their profession. There are at present in Upper Burma, 11,894 professed monks, besides 14,000 novices of whom many will return to the world after a longer or shorter period of discipline. In spite of every care to conciliate the ecclesiastical order, in spite of strict injunctions that the religion of the people should be respected and the sacred buildings untouched, in spite of the extension of elaborate courtesy by the highest military and civil authorities to the ecclesiastical dignitaries at Mandalay, and the lavish expenditure of money in the repairing of damage done to monasteries, it must be confessed that the monks were not of very great assistance in the restoration of order. Probably their influence is more potent in exciting than in allaying popular passion. Moreover, notwithstanding our good intentions, the position of the monks could not be so exalted under our rule as under the rule of the king. We could not afford direct support to Buddhist ecclesiastics, as the king had done to hundreds, if not thousands, of monks in Mandalay. Nor could the secular power be invoked to give effect to the decrees of spiritual courts. Our attitude towards the Buddhist religion has been as friendly as is consistent with the policy of the Government of India. The Thathanabaing, or Burmese Archbishop, has been encouraged to extend his jurisdiction over Lower Burma, and has been supported by all legitimate means. Quite recently steps have been taken to revive the public examinations in Pali, the language of the Buddhist sacred books, which used to be held periodically at Mandalay.

While devoting themselves with fervour to their religious observances, the monks also undertook the duty of educating the young. In the king's time they practically constituted the only educational agency in the country. Every village monastery was full of little boys, who went through the streets at stated hours, collecting the alms of the faithful for the support of their superiors, and who made evening and morning hideous by chanting their lessons in a shrill monotonous chorus. The instruction imparted by the monks was not extensive, but up to a certain point it was sound. I remember a rather well-educated Lower Burman clerk stumbling over a vernacular paper, which a bystander took from him and, with the help of a pair of spectacles borrowed for the occasion, read with fluency and expression. The beautiful handwriting of the clerks of the Great Council will soon be a lost art. Without in any way wishing to depreciate the advantages of English methods, I cannot help thinking that in Upper Burma, under native rule, the standard of vernacular education was higher than in Lower Burma, then or now. In this

matter, as in others, the policy of non-intervention has been pursued. While establishing a sound system of public instruction, the Government has abstained from needless interference with the monastic schools.

If in the preceding remarks I have succeeded in communicating some idea of the character of the people of Upper Burma, and of the influences by which that character was formed, I have to some extent furnished an explanation of the ease with which the monarchy was overthrown, the difficulty with which the permanent settlement of the country was effected.

From 1853 to 1878, Upper Burma was ruled by King Mindôn, the wisest of Burmese monarchs, who kept in his own hands all the threads of government. His son and successor, King Thebaw, whom, while yet a boy, a palace intrigue placed on the throne, was a ruler of a different stamp. Most of the stories told of his personal vices are fables or exaggerations. Judged by the standard applicable to Burmese kings, he was weak rather than wicked. Under the control of his wife, and under the influence of unworthy favourites, he began his reign by the slaughter of many of his relations; he alienated the English Government, with which his father had always kept on good terms; and he suffered laxity and corruption to overspread the administration of the State. In a short space, anarchy and disorder reigned throughout the country. The authority of the central government being loosened, each petty official did what was right in his own eyes, and even great Ministers of State looked to nothing but their own aggrandisement. Wise and virtuous men were excluded from the management of affairs and their advice was received with insults. The natural consequences were everywhere apparent. Bhamo was burnt by a band of Chinese marauders; a serious rising of Kachins in the north had to be repressed with ruthless severity; in the Shan country a league was formed to throw off the Burmese yoke and many States went into open rebellion. In Burma itself, the burning of towns and villages and the murder of governors were events of not uncommon occurrence. In every district bands of dacoits, openly or secretly countenanced by some great man, held the country side in terror. In a word, all social and political bonds were in a state of dissolution. When we first occupied Mandalay we found that we ruled little more than the palace in which King Thebaw had lived. We had to subdue and reduce to order the rest of the country. But it must be remembered that King Thebaw's successor, whether Burmese or English, would have had this task to accomplish. In addition, we had to conciliate or overcome the prejudices of the people against our rule. And there was this further difficulty, that we held every yard of land in which a Burman could find a home; there was no outlet for the lawless and discontented, such as, 30 years before, Upper Burma provided for the disaffected in Pegu.

The overthrow of the Burmese Government was effected in a fortnight. Only at the Fort of Minhla did the Burmese make a serious attempt to withstand our troops. The Burmese army, such as it was, never met us in the field. After the surrender of the king, this army melted away, its members spreading over the country, carrying guns and recruits to the dacoit bands already in existence, forming the nucleus of fresh gangs, in some few cases engaging in organised opposition to the new government. The settlement of the whole country, including the Shan States, but not all the fringe of hills peopled by savage tribes, occupied a period of nearly five years.

Immediately after the occupation of Mandalay, the pacification of the rest of the country was taken in hand. At first, the troops were insufficient to hold any except a few obligatory posts and to furnish columns for flying expeditions, but afterwards the military force was largely increased. All who know anything about the progress of events in Upper Burma are aware of the great work done there by our troops; of the devotion with which the long campaign, condemned, by its nature, to comparative obscurity, was prosecuted year after year; of the manner in which the army gave its best energies to the conflict with an enemy, whose defeat in numberless encounters involved all the hazards and labours of a great battle, with few of the conspicuous rewards of victory. It is not within the scope of this paper to describe any military operations in detail, even were I competent to do so; but, in sketching the progress of the civil administration in Upper Burma, I cannot, even at the risk of insisting on a truism, omit separate reference to the operations which made any progress possible.

It was at one time hoped that the work of dealing with the fragments of dacoit bands dispersed by the troops and of keeping order in the interior might be entrusted to a police force, of which the bulk should be drawn from

the people themselves. But the disinclination of Burmese and Shans to the restraints of discipline, and their lack of military qualities, rendered it impossible to give this experiment a fair trial in the midst of the urgent work of pacification. It was impossible to train a nation to arms on the field where the battle was still raging. So far, the only native race in Burma which has provided good fighting material is the Karen. A body of Christian Karens, raised in Lower Burma, has done excellent service as irregular military police. But at the beginning it was necessary to rely on the troops and on police raised in India for maintaining as well as for enforcing peace. About the middle of the year 1886, the first two battalions of Indian, or, as they came to be called, military police arrived in the country. This force was gradually increased till, at one time, it numbered nearly 20,000 men. It was recruited from among the fighting races of India, Sikhs, Panjábis, and as many Gurkhas as could be spared. In time, each district had its own battalion, led by one or two English officers of the Indian Army. The organisation of the battalions was similar to that of native regiments, though the establishment of officers was on a much smaller scale. Practically, these so-called police were soldiers in all but name. They performed no police duties, their part being to supplement the regular troops engaged in the work of pacification. Later on, when the pressure was relaxed, several battalions were transferred bodily to the Indian Army.

Extremely arduous was the work of destroying or dispersing the dacoit bands, many of them hundreds strong, which, under well-known leaders, infested the jungles of every district. Lurking in scarcely penetrable recesses, they seldom met our troops or police in the field. They were hard to find and bold and sudden in ambushes and surprises. At times they even ventured to attack military and police posts. But for the most part, after the first few months, they were content to wage war on their own countrymen, levying contributions for their support and enforcing their demands by the slaughter of headmen, the burning of villages, and the infliction of cruel tortures on men and women who fell into their hands. Hamlets not under the immediate protection of our posts were obliged to support these gangs with food, money, and arms. The dacoits were local men, with relatives in almost every village, from whom they often obtained information of the movements of our troops, and by whose agency they were supplied with means of subsistence. The difficulty of dealing with these marauders by military operations is obvious. Troops and police were vigourously employed in beating up their quarters and in hunting them to their lairs. Military and civil officers spared neither themselves nor their men in this warfare. The bad name which the climate of Upper Burma has gained is largely due to the effects of the hardships and exposure to which officers and men were subjected in this service. The process of pacification by these means would have been costly and laborious. It was necessary to attack the root of the evil, and, while constantly harassing the dacoits and keeping them in a continual state of alarm, to isolate them and deprive them of their secret supporters. The disarmament of the people, projected in 1886, was thoroughly carried out in the following years. As soon as the mass of the people were deprived of their arms, it was no longer possible for the dacoits to replace weapons lost in action by a foray or by friendly persuasion. Villages whose position laid them open to attack were compelled to surround themselves with substantial stockades and to maintain a system of watch and ward. Where this was ineffectual, and in remote localities where posts could not be established, villages were moved bodily to more suitable sites; while persons believed to be in league with dacoits were temporarily transferred to distant parts of the country. Care was taken to minimise the inconvenience of these removals; and it must be remembered that a Burmese village does not consist of solidly built wooden or masonry houses, but is a mere collection of mat and thatch huts, with light posts, easily shifted and re-erected at little cost. For the apprehension of noted leaders large rewards were offered, and dissension was sown in the dacoit ranks by liberal offers of pardon to the less prominent members of the various gangs, to men who, for the most part, were young or ignorant, more misguided than criminal. In no case, throughout this protracted struggle, were the rank and file treated with extreme severity. There was no mawkish sentimentality in the matter. No one in authority shrank from the responsibility of necessary measures of repression and punishment. So long as dacoit gangs held together, they were hunted down with all possible vigour. When a leader was given up or captured, he had a fair trial, and, if convicted, was duly hanged; though

any promise of pardon on surrender was observed with strictness which erred, if a all, on the side of mercy. But, while exercising just and necessary rigour against men known to have committed heinous crimes, the Administration never pressed hardly on the deluded mass. Hundreds of these were allowed to sue out their pardon, and return to their villages. Even to men under sentence of imprisonment and transportation, large measures of clemency were extended, as soon as the state of the country warranted their adoption. In a few exceptional cases, pardoned dacoit chiefs have been taken into Government service and have rendered material assistance. The result of this policy was, that by the middle of the year 1890, the last embers of disorder were stamped out, and the plains of Upper Burma became, as they have since remained, as free from disturbance as any part of the Indian Empire, a fact scarcely realised, I think, even yet by the British public. In the year 1890, the number of crimes of violence committed in Upper Burma was 532, as compared with 648 in Lower Burma, a province of about the same extent, of which part had been under our rule for more than 30, and part for more than 60 years. Of the progress made in the suppression of crime some notion may be obtained when it is said that in 1886, in Lower Burma alone, the tale of these offences rose to 2,844.

Side by side with the crushing of armed resistance and the establishment of peace, the building up of the fabric of civil administration was undertaken. From the first the country was mapped out into districts over each of which was placed a British officer with such staff as could be provided and with the support of such troops and police as were available. In the new order, room was found for the best of the old native officials. Many of these, far truer patriots than the men who brought fire and sword upon their country in pursuit of no definite policy and for no definite object, rendered services of inestimable value to the cause of peace, and too often paid for their loyalty with their lives. But these officials, even when sincerely attached to the Government, had been bred under a lax and corrupt system. Their methods were such as could not be tolerated. In the early days, after an engagement with dacoits, a worthy Burmese officer approached his English superior and asked, as if the inquiry were a mere matter of form, whether the prisoners should be crucified. Men of this class had clearly much to learn. It was necessary to train the subordinate staff, to provide for the administration of justice, for the collection of revenue, and for the initiation of the many beneficent measures by which the Government in India, most paternal of governments, endeavours to ameliorate the condition of the people. While purifying corrupt methods and removing barbarous excrescences, the Government desired to maintain the spirit of the native administration, and to interfere as little as possible with the customs and prejudices of its new subjects, above all things to avoid any attempt at imposing a brand new cut and dried system, inconsistent with the genius and habits of the Burmese race. The first short and simple rules issued early in 1886, for the guidance of civil officers, were framed with this object. The same purpose has been kept steadily in view ever since. While some oppressive imposts were abolished, no new taxes were levied in their stead. No encouragement was given to the natural tendency of officers from Lower Burma to model their districts on the pattern to which they were accustomed. As soon as possible, simple Codes of civil and criminal procedure were enacted, and so much of the law of India as could be made applicable was extended with suitable modifications to Upper Burma. From time to time other laws have been extended, and fresh Regulations have been made. Gradually method and regularity have been enforced. While disputing the ground inch by inch with armed bands of marauders, district officers had little leisure for ordinary administrative duties, and could not be expected to observe all the routine of official procedure or to furnish elaborate accounts, reports, and statements. As the country gradually settled down, the rough and ready want of system was abandoned. For some time past the administration of Upper Burma, furnished with a complete apparatus of Deputy Commissioners, Commissioners, and Judicial and Financial Commissioners, has been conducted as regularly and methodically as that of any other province.

The mass of the people of Upper Burma are agriculturists, living in small villages near their fields. Out of a total population of 3,063,426*, the dwellers in town number only 371,404, of whom almost exactly half are congregated at Mandalay. Practically, the village is the unit for revenue and administrative purposes. Every village has its headman, appointed with the consent

* Exclusive of the population of the Shan States.

of its inhabitants, who has to perform various duties and to undertake certain responsibilities. To enable him to discharge his functions and to maintain his authority, the headman is invested with substantial powers. He can invoke the aid of the villagers, and disobedience to his lawful requisitions is punishable by him at his own instance. He is the village magistrate, and sometimes the village judge, as well as the village tax-gatherer, with a per-centage on the collections. The community, as a whole, is held responsible for its own defence, for the payment of its revenue, and for its general good order. If without reasonable excuse a village fails to resist an attack by dacoits, if stolen goods, especially stolen cattle, are tracked to its limits, if serious crime is committed within its borders and the offenders are not detected, the whole village is liable to fine. In view of this joint responsibility, it is necessary that a careful watch should be kept on the movements of outsiders. Anyone who receives into his house a stranger is bound to report to the headman the arrival and departure of his guest. No new settler can take up his abode in a village without the headman's permission, and the district magistrate may be moved to order persons suspected of criminal leanings to betake themselves elsewhere. The community is thus bound together by common interest, as well as by local feeling. This system, which is quite in accordance with the customs of the country, has worked exceedingly well. It was put into legal form by a Regulation passed in 1887.

The village system is the basis of the revenue administration of Upper Burma. In former days, the public service, both civil and military, was supported by the grant, to high and low officials, of lands and even of towns and villages, which they were expressively said to "eat." King Mindôn was the first to substitute for this wasteful and oppressive plan the levy of regular taxes, and the payment of salaries to his officers and troops. Apart from the royal monopolies of certain articles of commerce, a source of revenue which was abandoned at the time of the annexation, the revenue of Upper Burma was mainly derived from the *thathameda*, and from the rent of royal or State lands. The *thathameda*, or tenth part, was a rudimentary income tax, levied on all classes except the inhabitants of Mandalay, who, apparently, paid no direct taxes of any kind. It was levied at a rate which varied in different places, but which usually came to about Rs. 10 on each household. The sum demanded from the individual taxpayer varied according to his means. The gross sum payable by a village was the rate multiplied by the number of houses. The incidence of the tax on the members of the community was regulated by the people themselves. In each village assessors were appointed and solemnly sworn at the village pagoda to do justice. By these assessors, the sum payable by each householder was determined, the community being jointly responsibe for the gross demand. This system is still in force, though its abolition is threatened. Land revenue, properly so called, was not levied under Burmese rule. Cultivated land was divided into three classes—(1) Royal, or State land; (2) land held under various tenures of a feudal nature; and (3) private, or hereditary land. The State land was let out to tenants at will, who had to pay a fixed proportion of the gross produce. Of service tenures there were a surprising number and variety. Private land was not subject to any incidents of service or to the payment of revenue. The land system was not very precise. But, apparently, uncleared land could be taken up, and when brought under cultivation became the private property of the farmer. Under our rule, the distinction between State and private land is still maintained; on the latter no revenue is levied. Land held under service tenures is classed as State land, the incidents attached to it being commuted for a revenue assessment. Unoccupied land is now the property of the State and, when brought under cultivation, is subject to revenue. In several districts survey and settlement operations have been undertaken for the purpose of ensuring a correct classification of the cultivated land, as well as in view of the reform and elaboration of the revenue system.

A few statistics of the revenue of Upper Burma may be of interest. In the first year of our occupation we managed to collect 22¼ lakhs of rupees. In the following year the revenue was more than doubled, while in the year 1891-92, a year in which wide tracts were visited by scarcity and threatened by famine, the net demand exceeded Rs. 85,00,000. In that year the actual receipts in the public treasuries amounted to 120½ lakhs of rupees, rather more than one-fourth of the sum received in Lower Burma. Of the total revenue of the year, 43 lakhs were derived from the *thathameda*, nearly 10 lakhs from State lands, and 13¼ lakhs from forests.

The development of the material resources of the country has been steadily kept in view. Next to the establishment of peace, the most urgent need of Upper Burma was the improvement of means of communication. Of the measures taken to meet this want, one of the earliest was the extension of the telegraph system. Telegraph lines were not unknown to the Burmese, but nothing like the elaborate network of wires which now covers the whole country, from the Chin hills in the west to the heart of the Shan States in the east, from Mogaung in the north to the frontier of Pegu, was ever imagined by any Burmese ruler. At the end of 1890-91 more than 4,000 miles of wire were working in Upper Burma, over which 681,000 messages were flashed during the year. Of even greater moment was the opening up of the country by railways. Within a year of the occupation the construction of the railroad from Toungoo to Mandalay was begun. This line traverses the eastern districts, skirting the Shan border and piercing a land-locked country, through which means of communication were few and difficult. The first thought of a distinguished Burmese Minister, on hearing of the projected construction of this railway, was that he and his friends would be able to get *duriâns* fresh and cheap. The *duriân*, I may explain, is a fruit with an odious scent, and, to my taste, an equally odious flavour, which grows in the South of Tenasserim, and of which the Burmese are so fond that in the king's time a special steamer used to be chartered every year to bring a cargo of it for the delectation of the Court. The railway did more than supply Upper Burma with fresh *duriâns*. Its construction provided labour for a number of people, and materially assisted the pacification of the eastern districts, at first among the most turbulent in the province. When opened in 1889, it linked Mandalay and the intervening country with the sea, brought to market the produce of the rich plains through which it passes, and enabled the people to make with ease and at a trifling cost journeys which before were difficult and expensive. From the very first the Burmese have taken kindly to the railway. Among the crowds which fill the trains are throngs of Buddhist pilgrims from all parts of the province, even from the country beyond the Salween, journeying to pay their devotions at the shrine of the Shiwe Dagôn pagoda in Rangoon. Other railway projects have been taken in hand or are under consideration. A line is being constructed from Sagaing, a former capital, just below Mandalay on the right bank of the Irrawaddy, northward through the fertile tracts of Shwebo and Wuntho, where in 1886 unhusked rice was selling at Rs. 10 the hundred baskets, to Mogaung in the Kachin country, the depôt of the jade stone and rubber trade. Part of this line is already open, and before long Mogaung, which has been under effective control for less than five years, will be a busy terminus and the lovely lake of Indawgyi will be as accessible to tourists as Lucerne. As regards the prosperity of these lines, I am unable to quote separate figures for Upper Burma. But the following statistics are sufficiently significant. In 1888, the year before the opening of the Mandalay line, the net earnings of Burma railways amounted to Rs. 12,72,000, or 3·76 per cent. on the capital expenditure. In 1890, the first complete year of the working of the Mandalay extension, the nett earnings were Rs. 23,48,000, or 4·7 per cent. on the capital expenditure. In 1891, the gross earnings of Burma railways were Rs. 58,55,000. In the first six months of the current financial year the gross earnings amounted to Rs. 36,71,000, or nearly 25 per cent. more than in the same period of the previous year.

Law-courts, public offices, jails, and police-stations have been built in every district, while road-making has been undertaken to the extent of the funds available. In 1890, out of a total outlay on public works of over 43 lakhs, more than 12 lakhs of rupees were spent on land communications; and at the end of that year more than 2,000 miles of roads were under the care of the Public Works Department. Among the most important roads are those which open up communication through difficult tracts with the Ruby Mines, the Shan States, and the Chin Hills. In a country where the rainfall is variable, the prosperity, in some places even the life, of the peasantry depends on an artificial water supply. Irrigation works of magnitude and importance were constructed in former days, but were, for the most part, suffered to fall into decay. Some of these have already been put in order and a complete scheme of irrigation is being worked out. Much of the country is upland, where wheat and other dry crops can be grown, an agreeable and profitable variation of the eternal paddy fields of Lower Burma. In the hills, land suitable for tea and coffee can probably be found. The forests, which, in the king's time, were worked with wasteful energy, are now under scientific control. Properly

managed, the supply of teak and other useful timber is practically inexhaustible. The country is rich in minerals, a source of wealth which needs only increase of population and the opening of communications for its development. Besides the ruby mines at Mogôk, and the jade-stone quarries above Mogaung, coal mines and oil wells are being worked. Lead and silver are found in various places. The presence of gold has long been known. In 1886 I heard that, by laborious washing of auriferous sand, some industrious people earned a steady income of four annas a day each. Recent reports, not yet I believe confirmed, promise a richer harvest from this industry.

Among other material benefits of our rule may be mentioned the establishment of local hospitals, and the provision of medical and surgical aid for the poor in every district. These boons are fully appreciated. Nearly five years ago, riding in the interior of Upper Burma, I met a string of men, women, and children walking to a neighbouring town as if to a fair or market. On inquiry, we found that they were all going, of their own accord, to be vaccinated. In the year 1890, nearly 100,000 patients, that is, more than 1 in every 35 of the total population, were treated in the town and country hospitals. In the scarcity which prevailed a year ago, relief works were opened, and advances to the amount of more than four lakhs of rupees were made to agriculturists for the purchase of seed and cattle. The forethought of the Government in these matters comes home to the hearts of the people, and helps to soothe whatever regret they may have felt for the extinction of their national independence.

While the whole face of the country has been changed in the last seven years, nowhere has the transformation been more complete than in the capital. Mandalay is a modern town, built by King Mindôn, who, in accordance with an established custom, removed the seat of government thither from Amarapura. In 1885, it consisted of the square walled enclosure, long known as the city, but now honoured with the title of Fort Dufferin, and of a straggling native town stretching southward to Amarapura and westward to the river bank. The city is surrounded by a moat and by battlemented walls, pierced by five gates. In the centre of the city, planted in a well ordered garden and defended by a strong wooden stockade and by an inner wall, stands the palace. In the midst of the palace, on the east side, rises a graceful spire crowned with a jewelled ornament, or *ti*, an object of deep veneration. The main part of the palace consisted of a mass of wooden buildings overlaid with gilding and barbaric decoration. In the outer enclosure stood the *hlutdaw*, or State council chamber, the small golden *kyaung* or monastery, a model of the *kyaung* where the king passed his noviciate, and the tombs of King Mindôn and his consort; while at the eastern gate stood the tower of the *Bohozin*, the drum which was beaten to tell the time of day and night and to proclaim aloud that the king was at home. The palace has been maintained, though many alterations have been made, and though the wooden stockade has partially, if not wholly, disappeared. For some time after the occupation the palace was used as a barrack and as quarters for the principal military and civil officers.

In the king's time the walled city was traversed by wide straight streets running parallel with the sides of the palace stockade. The spaces between the streets were crowded with houses, principally those of Burmese troops and officials. Round the palace were grouped the dwellings of the great Ministers of State, each in the midst of a spacious enclosure which accommodated scores of retainers. During part of the hot weather of 1886, destructive conflagrations raged almost nightly within and without the city. Once or twice the palace itself, which, if once fairly alight, would have burnt like tinder, was in imminent danger. Of these fires, some were the work of incendiaries, but most were the result of accident. During these few weeks, the Burmese in Mandalay maintained an attitude of listless indifference, partly characteristic, partly the sign of disaffection. They would sit by placidly, watching the flames which consumed their houses, without moving a finger to save their property, but sometimes taking the trouble to ask a busy Englishman to be so good as to snatch some specified valuable from beneath a burning roof. As the months wore on, the people gradually threw off their reserve and resumed their wonted callings. Trade revived, and again the great bazaar was filled with buyers; Shan pedlars and bullock drivers once more loitered, open-mouthed, in the streets; and crowds of pilgrims, as of old, pressed to the feet of the sacred image, called the Arakan Pagoda. The Queen's Jubilee was celebrated at Mandalay in February, 1887, *pwès*, that is to say, dances and theatrical performances, being

held day and night for a week in the presence of multitudes of spectators. As for the walled city, which had been partly cleared by fire, it has been swept bare of all native habitations, due compensation for disturbance being given and suitable sites outside the walls being provided for evicted householders. The vacant space thus acquired is now the principal part of the cantonment. Though no longer the seat of Government, Mandalay is still regarded as rather more than a mere divisional headquarters. On the city wall stands a Government-house where the Chief Commissioner resides during a part of the year; while as a principal railway terminus, and as one of the depôts of the Shan trade, Mandalay yet enjoys commercial prosperity. It is still the largest town in Burma, containing a population of nearly 188,000. For some years it has enjoyed municipal government and it owes much to the intelligent care of the city fathers. In the town, broad and well laid streets have replaced the rough roads of former days; while the crowning achievment of modern progress, a tramway, is in course of construction. Municipal government, it may be remarked, was introduced at an early date into all towns of any importance in Upper Burma, even in some tiny places whose income is less than £1,000 a year. Town councillors are appointed by the Government, the elective system being as yet in abeyance.

In conclusion, I must say a few words about frontier affairs. To deal adequately with them would take far more time than can be spared. The acquisition of Upper Burma brought us face to face with the wild men of the Chin and Kachin Hills on the west and north, savages whose only ideas were war and plunder, sunk in the grossest superstitions, and for generations accustomed to find their pastime in raids on the plains or in the pillage of caravans; with the Shans, a fragment of the great nation which, centuries ago, held the whole of Further India, who still occupy the country east of Upper Burma up to and beyond the Mèkong River. Of the Chins and Kachins, it must suffice to say that by the despatch of punitive expeditions and by the establishment of military posts in their midst, much has been done for the establishment of order. Year by year, since 1887, progress has been made; but the civilisation of these wild men is a work which takes time. As to the significance of the border fighting, which is still going on, I cannot do better than quote Sir Charles Aitchison's words:—

"Frontier raids, as Lord Dalhousie observed, are no more to be regarded as interruptions of the general peace in India, than the street brawls which appear among the every-day proceedings of a police-court in London are regarded as indications of the existence of civil war in England."

In the Shan country, which, at our coming, was a scene of the wildest confusion, the restoration of order was accomplished with scarcely any bloodshed but not without the exercise of infinite labour and tact by the officers to whom the task was entrusted. It is now more than four years since there has been any serious trouble in this part of the province; the only corner where a little fire still breaks out from time to time being the Kachin border in the north. Probably, the rivalries between the several States helped to prevent sustained resistance. However this may be, the submission of the Chiefs was prompt and genuine. In the administration of the Shan country a curious and interesting experiment is being tried. Now, as in the time of the Burmese kings, Shan-land is divided into a number of mutually independent States, each ruled and administered by its own hereditary Chief. These States are not feudatories, but actually part of British India; yet every Chief has the power of life and death, and, so long as he abstains from cruel and savage practices and from grievous oppression, his authority in the management of his State is unlimited. Two English officers, styled Superintendents, are stationed, one in the north and one in the south, to exercise general supervision and control. Certain sources of revenue, such as teak timber and minerals, are, as in the king's time, reserved by the Government. The rest of the revenue payable to the supreme Government is a lump sum levied as tribute on each State. The Chief is responsible for the tribute, which he raises by any legitimate means. A very simple code secures some attention to ordinary legal forms, and forbids barbarous and excessive punishments. A Chief is not allowed to enter into relations with other States, and is expected to listen to the advice and, if required, to obey the orders of the Superintendent. But practically the internal administration of the States is left without interference. Thus in the Shan country, which has an area of at least 40,000 square miles, there are not more than half a dozen British officers, not a thousand troops, and no police of any kind. Yet the country is perfectly quiet and free from crime of a serious description. The Chiefs of States which in former days were

engaged in constant feuds now meet as friends at the Superintendents' durbars. The people devote themselves to agricultural and pastoral pursuits, and most of all to trade which has been much facilitated by the construction of cart roads. The administration of the Chiefs is not the best imaginable; it is not to be compared for a moment with that of the zealous district officer; but it is cheap, and it suits the people better than our more elaborate system.

I have had time barely to indicate the manner in which Upper Burma has been administered, and some of the improvements which have justified our conquest of that country. Our rule in Burma, as in other parts of India, is progressive. We do not profess to have finished the work of civilisation. But we may fairly say that a broad and solid foundation has been laid; that we have bestowed peace and freedom to reap the fruits of their labours on a people long subject to oppression and a prey to civil discord; that true national life has room for healthy growth under the protection of just and equal laws; that the races of Upper Burma now enjoy a larger measure of material prosperity than in the brightest days of the Burmese sovereignty.

DISCUSSION.

The CHAIRMAN said his only qualification for occupying that position was that he was a soldier, and he did not know that that made a man a good speaker, especially when his soldiering had been carried on at the remote frontiers of the Empire. However, the very able and instructive paper they had heard had forestalled him in much of what he might have said. He had taken part, as the commander of a brigade, in the expedition of 1885 up to Mandalay, and he was continuously present in Upper Burma until, in 1889, the improved condition of the country enabled the army of occupation to be considered no longer as a force in the field. He also knew something of the causes which led to the necessity for the occupation. Englishmen, as masters of the greatest Empire in the world, would agree that that country was in its decline that could view, without taking action, the undue aggrandisement of a neighbour and rival; and there were indications of intrigue at the Court of Mandalay which rendered it necessary for us, in the interests of the integrity of our Eastern Empire, to interfere with the cruel yet weak Government of Thebaw, who would listen to none of our repeated representations, nor render even scant justice to those who were dependent upon us for support and protection. It was, therefore, determined to send an expedition against Mandalay, and the route used was the grand waterway of the Irrawaddy, a line of communication which was most excellent. Previously in the same year, 1885, he had made the campaign of the Nile, and the hardships then endured were emphasised in his mind by contrast with the wonderful facilities in the way of transportation afforded by the Irrawaddy Flotilla Company. The first opposition met with was at Minhla, but that was wiped out in a few hours, and on arriving at Mandalay, the place fell into their hands without a blow. The chief Ministers of State came out to meet them, and the people were apparently prepared to receive them. They stood in dense but orderly rows, and, as far as could be judged, enjoyed the spectacle of a British army marching through the streets. A Burman enjoyed a show above all things, even at the expense of a little patriotism. With that tender regard for the feelings and customs of those we ruled, which, he thought, was a characteristic of British rule abroad, it was hoped that we should be able to carry out the government of the country through the local council which was in existence, headed of course by the able Chief Commissioner, Sir Charles Bernard. The idea was to interfere as little as possible with the customs and prejudices of the people. It was easy to be wise after the event, and experience soon showed that the local council, deprived of its chief, the king, was the merest torso, without a head to direct or limbs to move. The country was in a state of anarchy, and everyone did "that which was right in his own eyes," according to Mr. White. He would enter a slight protest against that way of putting it; because it contained a grave imputation on the conscience of the Burman. Everyone undoubtedly did that which was likely to feather his own nest, but he acquitted the Burman—an intelligent man educated in the principles of Buddhism—of thinking that he was doing right. It was notorious that the chief Ministers of State were in league with the dacoits, and were not ashamed to share the spoils, rendering them protection and giving them timely warning of any expedition sent against them. It thus became a greater danger to give information against a dacoit than to be a dacoit. As they pushed their reconnaissances into the interior, they found the same state of affairs everywhere. The strong were lawless and preyed upon the weak, and as their *rôle* was to defend the weak, they encountered enemies everywhere. The expedition sailed up to Mandalay, but when they landed, and the bands of dacoits began to collect, the action of the troops was restricted for the want of land transport. A dog, even a very small one, might bark with impunity at a very big fish in the river, because the fish had no opportunity of showing his superiority, and that was the position for some time of the British force in Burma, but when their land transport was properly organised, they were enabled to push the margin of their influence further into the interior; and it was soon apparent to all observers that the conquest of Upper Burma was going to

be a much tougher job than had been anticipated. The policy of India was luckily directed by strong heads — Lord Dufferin as Viceroy, Sir Frederick Roberts as military chief, aided by Sir George Chesney as local Secretary of War—and these able statesmen and soldiers soon realised that there was nothing so dangerous to our prestige in the East as carrying on a campaign with inadequate means, and that there was nothing which eventually made so heavy a drain on the local Treasury as a protracted campaign. It would be too tedious to detail how gradually the power of the English was extended. Everywhere the same enemy, dacoity, was encountered. It was a perfect hydra. No sooner was a head lopped off in one direction than another cropped up hard by. It must not be supposed that they were among their own people social outcasts. On the contrary, the brave Bo, the bold raider, was the hero of popular song and story, and the favourite of the village belle. He swaggered about in soft silks when he was not heading a raid, and in some cases the dacoit chiefs were the absolute patrons and protectors of the villages in their own immediate neighbourhood, from which they drew their recruits. He remembered one instance of a dacoit chief who was the terror of the surrounding districts, and when at last the troops got on his track, fought him and killed him and several of his band, the villagers in his immediate neighbourhood petitioned the officer in command that a military post might be left for their protection; explaining that the dacoit had been their protector hitherto, and that under his leadership they had been accustomed to help themselves at the expense of their neighbours, but that now this position would be reversed. It was soon recognised that where there were arms there would be dacoits, because arms were the prize which above all else they coveted. An order, therefore, went forth for the disarmament of the people. In those days the executive Government in Burma was criticised by no very friendly pen, and this order was denounced as handing over the law-abiding, unarmed, and defenceless to the mercies of the armed, lawless, and strong. But those who knew Burma best knew that no Burman with spirit enough to be respected among his fellows would allow a gun to hang up idly in his house. The Burmese knew enough of soldiering to know that the essence of defence was attack, and they practised that principle. In tho e days an Upper Burman would have looked on a gun hanging idly on his walls as so much unemployed capital, and neither he nor his thrifty wife would thus have buried their talent in a napkin. Mr. White had represented the Burman as a coward, and he must confess to have seen him on more than one occasion run away on very slight provocation; but, on the other hand, he was a bold horseman, and in their national games, boat-racing especially, he showed great endurance and pluck. Courage was really the effect of self-discipline and self-control, and the Burman had very little of either. He lived for enjoyment, and followed his own inclination. He knew a case of a Burman servant who sacrificed over two months' pay rather than be absent from a *fête*. After all—and this was the great point with regard to courage—he had never met with a race with so small an idea of discipline. It was almost impossible to organise a police force amongst them. A story was told him of an important prisoner being sent under escort from the county jail at Mandalay to some outlying prison, but when the escort returned, and the officer in charge was asked for his receipt for the body of the prisoner, he replied that he had not got it, the man had run away; and, when asked for a further explanation, he said they could not help it, he ran away while they were asleep. If he were asked, who were the agents who had succeeded in bringing about the pacification of Upper Burma, he should answer unhesitatingly, the officers and soldiers, British and native, of the Burma field force. There never was a campaign in which so much initiative was left to the junior officers. Dacoity was everywhere, but there was no army of any importance in the field; the country was, therefore, divided into a number of districts or circles, and a military post was placed in each, the officers in command being often subalterns. Their orders were to keep a strict watch on everything going on, and to disperse any gangs of dacoits within reach. As British officers always did, they answered nobly to the responsibility thrown upon them. Upper Burma was conquered by regimental officers and subalterns, aided by their men, who soon learned to have unbounded confidence in them. The improved education of the officers was also made very apparent in that campaign in a practical way. There were no maps, the country never having been surveyed, and he, therefore, issued orders to the officers in charge of districts to send in sketches, all drawn to a certain scale. These sketches were put together by the field force at head-quarters, and made up into a very accurate map, from which he was able to direct operations and even combine movements from different bases. If a similar task had been assigned to the officers of Wellington in the Peninsula, he feared the survey officer at head-quarters would have had considerable difficulty in making the corners meet. The military operations commenced in 1886, and before he left, in 1889, he saw communication established between the capital and the sea at Rangoon, and that great pacificator, the locomotive, entering the walls of Mandalay, which but three years before had been the scene of military executions carried out on murderers and incendiaries, who had committed their deeds of violence almost openly in the light of day. When such clouds lowered over the land, they could not be dispersed by showers of rosewater; but England sheathed the sword as soon as the peace and prosperity of her subjects would admit; and she pre eminently amongst the

nations had softened the old harsh cry *Væ victis!* into the fairer prospect of peace, prosperity and plenty to those who owned her rule.

Mr. TAW SEIN KO said that a strange fatality seemed to attach itself to some of the most ancient empires of the East, and the Empire of Burma, which had now been fully annexed by the British, was a good example. The life of nations was something like that of individuals: an individual grew to manhood, then to maturity, and finally sank into decay. In the same way a nation attained to national prosperity and greatness, and the highest point of civilisation, and then a period of effeteness and corruption set in, and it was as impossible to arrest that stage of decay as to arrest the declining years of an old man. At one time, the Burmese nation was dominant in the Indo-Chinese peninsula. At several periods of its history the Burmese Empire might be roughly defined as being bounded by the Malay Peninsula on the south, by China on the north, by Assam on the west, and by the river Mekong or Cambodia on the east; and further, the magnificent remains at Pegu, Prome, and Pagan fully attested the national prosperity and high degree of civilisation of the Burmese nation. Such a state of civilisation and wide dominion could not have been attained without courage, discipline, self-control, power of organisation, and acquaintance with the methods of government. Later on, the Burmese nation came in contact with the European Powers—the French, the Dutch, the Portuguese, and the English. The English succeeded in establishing themselves in several parts of Burma, and finally they annexed the provinces of Arracan and Tenasserim in 1824, and Pegu in 1852; and the Burmese race was confined to a small tract of country to the north of Lower Burma. The question of the annexation of Upper Burma was hotly discussed in the papers at the time, but, being now an accomplished fact, it was hardly advisable to re-open the question. It, however, taught two useful lessons—the importance of the organisation called the village community, and the political wisdom of preserving and improving certain usages, institutions, and methods of government, which were found interwoven with the habits, traditions, and genius of a people over whom *pax Britannica* had been extended. It was owing to the existence in the Shan States of this native institution that a peaceful and permanent settlement was effected in so short a time, and almost without any bloodshed; but in the plains of Burma proper the *quasi*-independence and usefulness of the village communities had been much impaired by the innovations introduced since 1852 by King Mindôn, who was anxious to maintain the full regal splendour of his forefathers, although he had much less territory to rule. In the Shan hills the British authorities had to deal with well-defined groups of men, owing allegiance to common chiefs; whereas in the plains they had to deal with masses or bands of men amongst whom the bonds of union or organisation had been broken or loosened. The importance of this institution had been recognised by the British Government, and the Indian Legislature had passed certain Acts to ensure its continuance. In those Acts, as well as the regulations applicable to the Shan States, had been preserved certain forms and usages of the old régime which were in harmony with justice, equity, humanity and good government The wisdom of such a policy had been amply demonstrated by the unqualified success that had attended the British administration of Upper Burma. During the first years of the annexation, the work undertaken and performed nobly and well by the British authorities was of a most arduous nature: the hydra-headed dacoity had to be crushed, roads, bridges, railways and telegraphs had to be constructed, and the fabric of an efficient civil and military administration had to be built up. With regard to dacoity he would like to say a few words. It appeared to be an ancient institution peculiar to Burma, as brigandage was to Italy and Sicily. It was nothing but an organised form of force which was a necessary complement of the village community. In the absence of a powerful and irresistible sovereign, it was the only method by which force could be repelled by force, and private or public wrongs could be righted. Some dacoits no doubt had a political or patriotic object of freeing their country from foreign invaders. History was not generally studied in Burma, and the historic memory of the Burmese was remarkably short. They had forgotten the lessons of 1824 and 1852, and with the superciliousness of a nation surrounded by insignificant tribes, and the pride of a people proud of their great historical past, they imagined that the work of resistance would be easy, and that they would be able to drive the heretic *Kalas* to the sea. There seemed to be some misconception as to the derivation of this term "Kala." It originally meant a native of Gola or Ganda, the modern Gaur, in Bengal, from which Burma was colonised in ancient times, and then came to be applied to a native of India, or any person, European or Asiatic, who came from that country to Burma. It was hardly correct to say that it meant a foreigner, because it was never applied to the Chinese, Siamese, or Malays. The bulk of the Burmese were inclined to treat foreigners like the ancient Greeks or modern Chinese do; and soon after the annexation of Upper Burma, the attention of the Government was directed to the large hierarchy of Buddhist monks, and to the necessity of adopting some of the native methods of public instruction, side by side with Western education. In accordance with the declared policy of neutrality, the Government of India, which was necessitated by the division of the Indian peoples into innumerable sects, the Government of Burma had not gone much beyond the mere recognition of the Burmese Archbishop, as the chief ecclesiastical authority of United Burma. But considering that in Burma, unlike in India, there was much homogeneity in religious opinion, it was a

question whether a liberal support, given to this large body of monks, would not have gained their good-will, enlisted their sympathy, and induced them to use their undoubted influence on the side of peace and order. As regarded the educational question, the examinations in the Pali language, which used to be held under the late Government, had been revived, and a recent resolution of the Chief Commissioner directed that public instruction, up to a certain standard, should be imparted through the recognised vernaculars of the province. Time would show the results and the far reaching character of these wise measures. There could be no doubt that, under British rule, United Burma was entering upon a forward path of regeneration, progress, and civilisation.

Mr. J. Annan Bryce said he was not able from past experience, to corroborate the extraordinary account of progress of Burma given in the paper, because his experience, which was considerable, dated from a time previous altogether to the war. He was a great deal in Upper Burma and Mandalay, and elsewhere, for several years before the war took place, and he fully justified what Mr. White had said about the state of anarchy into which the country had fallen. Perhaps owing to the history having been written by English newspapers at the time, Mr. White, although he had said but little about ferocity in the original description of King Thebaw, had still painted a little too darkly his share in those affairs. He (Mr. Bryce) saw him frequently, and should say that he was a rather stupid, sensual, good-natured young man, with no cruel tendencies about him more than the average Burman, and the average Burman was not naturally cruel or brutal at all. Thebaw, however, was young, and the son of an inferior wife of the king; his mother a Shan woman of no great rank; his wife, who was the evil spirit of the dynasty, was the child of a superior wife, who, according to the custom of the country, was related closely to the king himself. Therefore, the wife, who under any circumstances would have had considerable power due to her generally greater intelligence, had, in this case, the added superiority of much higher rank. The result was that she really managed the affairs of the kingdom; and being of a fiery and spiteful disposition, brought him to ruin. It was not fair to accuse Thebaw of being the cause of the massacres. They were a distinctly political measure, recommended by the Ministers of the old king, and carried out by one of the Ministers of the young king. The man with the greatest power at the time when Thebaw succeeded, in 1876, was the officer of the South Gate of the Palace. He remembered very well, on one occasion, the old king had asked a number of Europeans in Mandalay to breakfast, and this man, who afterwards became Prime Minister, gave them a very rough reception, and ordered them to take off their shoes before entering. He (Mr. Bryce) sent a remonstrance to the king, and next day they were requested to come back again, when this official received them in a very different manner, having had orders so to do. A few months after Thebaw's accession, the massacres were recommenced by one of the ministers of the old king, really before the young queen and Thebaw had begun to feel their feet. There was a good deal to be said for it on the ground of policy at the time, but he did not think the instruments of the British Government could be entirely free from responsibility in the matter. The Resident who was in Mandalay at the time did not sufficiently understand the conditions of the time, and allowed himself to be approached by various pretenders to the throne; and the Government, which was being carried on under the name of Thebaw, was bound to protect itself. Finding these intrigues, it took the short, speedy, and old hereditary method of cutting off the heads of all the people of the royal race that could be found. It was a drastic measure, but it was difficult to say whether anything else would have done under the circumstances. Thebaw himself had nothing to do with it, and the queen practically had very little. The king, up to the last day of his rule, no doubt suffered the pangs of remorse for what had happened; for he had been brought up in a monastery, amongst the monks, and anything in the nature of slaughter was extremely repulsive and repugnant to him. He had very little doubt that he took to the use of strong stimulants afterwards, in a great measure to drown the remorse which he suffered on this account. With regard to dacoity, he should be inclined to take the view of Mr. Taw Sein Ko, that it was, after the war, largely supported by a sentiment of nationality. Although he said the time was past for discussing whether the policy of annexation was right or wrong, he was not at all inclined to take that view, because similar circumstances might occur again, although perhaps hardly within the bounds of India, when the question would have to be considered. In this particular case he could not help thinking that if the Government, instead of proceeding by way of direct annexation, had proceeded by way of mediatising Upper Burma, they would have avoided a great deal of the subsequent disaffection, and a settlement might have been managed through the means of British officers, perhaps not quite so effectively and rapidly, but with much less bloodshed, and perhaps with nearly as great eventual results. With regard to dacoity, he remembered once meeting a forester from one of the most important Shan States, and it being a hot day, the man had his clothing open, and he noticed a number of lumps and knobs over his breast. On asking what they were, he told him they were rough sapphires, rubies, bits of gold, and so on, which were charms against wounds. On asking him what he wanted such things for, as he was simply a forester, he said he was brought up as a dacoit, speaking of it as if it were one of the most ordinary and honourable professions. The Burmans in fact did not look upon this highway

robbery as Englishmen did at all, but thought of it as a trade which under certain circumstances was one not at all to be ashamed of. The feelings of the Burmese of the time must be considered. They say that their existence as a nation was at stake, and no doubt many of them had for mere purposes of gain taken up this life of robbery, but many others from purely patriotic motives. He believed that not only would that evil of dacoity have been considerably diminished, but the difficulty with the frontier tribes would have been considerably less if annexation had not been carried out, because it was possible in the old days to permit of a much more loose state of things on the frontier than it was with a highly civilised Goverment, such as that of India. These Chins and Kachins, now giving so much trouble to the Chief Commissioner, were always raiding in the same way, both in the time of King Thebaw and his predecessor. All the great region west of the Chindwin River had practically gone out of cultivation owing to the raids of these Chinese.

Sir CHARLES BERNARD, K.C.S.I., on behalf of the Indian Committee of the Society, begged to tender to Mr. White their warmest thanks for the excellent paper he had read; in which he had managed to compress a wonderful amount of information into a small space and a short time. He believed he was the most competent living authority on the subject of which he had treated, having been, for five years after the occupation of Upper Burma, Secretary to the Government. He knew the country, the language, and the people well. He liked them well, and they liked him well. He had seen Upper Burma from several points of view, and conducted the first mission sent from Mandalay to the Shan States, but he had not said anything about the part he took in the pacification of the country, though he might fairly have said, *quorum pars magna fui*. It was often said that they did these things better in France, but that would hardly apply here. A few years before the annexation of Upper Burma, the French had taken another very large tract of country in South-Eastern Asia, and an examination of their success in that direction would not lead to the conclusion that they managed these things so much better than the English. The country they took marched with China, and the first thing which happened was that the French got into hot water with the Chinese, who sent parties across the border to cut up small parties of French troops, and added enormously to their difficulties. Upper Burma also marched with China, and the Governor of Yunan was the same man who had sent down the black flags into Tonquin; but whether it was owing to the regard that the Chinese had for the British, or was due in part to the kindly and wise diplomacy of Lord Rosebery, or to the sympathetic behaviour of the Government in India, the Chinese did none of these things to us. They sent no black flags into Upper Burma. They did not foment cruel warfare against us. On the contrary, they renounced the shadowy sovereignty they formerly claimed over Ava; and they waited quietly until the British could find time to have a joint delimitation of boundary between Upper Burma and China. In Upper Burma resistance was quelled much sooner, peace was restored earlier, a larger revenue had been raised, and a far greater expenditure incurred in improving and developing the country, than took place in the first five years after the French took Tonquin. Something had been said about the unhealthiness of Upper Burma, although Mr. Taw Sein Ko said it was a genial climate; and at first no doubt there was a great deal of unhealthiness. There were many deaths and much invaliding among the troops, principally owing to the exposure, bad food, and hardship; but the mortality was very far less than occurred to the French in Tonquin. In Tonquin during August, 1885, 1,200 French soldiers died of cholera, and in the same month of the following year 250. There was no mortality of that kind amongst the Queen's forces in Burma, but they were carefully looked after by the Qneen's doctors in the hospitals and barracks. And last, but not least, in Tonquin, during the time of the French occupation, the civil, naval, and military forces were often at variance. In Burma, on the other hand, the naval, military, and civil authorities acted in concert, and if there were divergences of opinion, they did not produce divided counsels or divided action, and the public outside heard nothing of them. Much of the good result in Upper Burma was due to the soldierly qualities, the foresight, wisdom, and unaffected modesty of the gallant officer, whom the Society and the meeting were glad to see in the chair that evening.

Sir CHARLES TURNER, K.C.I.E., in seconding the vote of thanks, said the highly distinguished officer in the chair commenced by saying that he was not a man of words, but of action, but the native eloquence of the Irishman spoke out in his address, and he had given a chapter of history which would surprise very many, and the very brief mention of the part he had taken in the work would justify his selection to the highest military post in the Indian Empire. In his hands they might leave, with all confidence, not only the safety and interest of the Empire, but that policy of justice which had distinguished all our great commanders and chief military men.

The vote of thanks was carried unanimously, and the meeting adjourned.

General Sir HARRY PRENDERGAST, K.C.B., V.C., writes:—Mr. Thirkell White states that "though arrogant and boastful, the Burmese, as a race, were not courageous, and, at the least sign of resistance, were quite prepared to fly for their lives." And Sir George White says, "It is said that the Burman is a coward, and I have seen him run away on

very slight provocation. But the Burman is a bold horseman, and in his national games, especially boat-racing, he shows great endurance and pluck. Courage is really the effect of self-discipline and self-control, and the Burman has very little of either." There seems to me to be scant justification for the assertion that the Burmese are not courageous and are great cowards. I think it is a poor compliment to our soldiers and sailors, who were beaten by the Burmese in former wars; and every student of military history knows that we were defeated by the Burmese in many affairs. If a party of European civilians—French, German, Italian, or Russian—provided with sticks, spears, swords, and a few fowling pieces, were attacked by battalions of soldiers armed with the best rifles, and supported by artillery, would the civilians be branded as cowards if they were to run away, when bullets and shrapnel give them the signal of the enemy's approach? I trow not. Why, then, should Burmans, who are quite unacquainted with long-range rifles and projectiles, be vilified because they do not relish being slaughtered by an enemy quite out of their reach? During the advance on Mandalay, it was the duty of the Burma Expeditionary Force to attack the Burman division at Myingyan, on the 24th November, 1885. The bulk of the enemy's infantry were massed out of range of the British artillery, but the field works on the left bank of the Irrawaddy river, that had been thrown up in the preceding 24 hours, were manned, and the Burman light field guns were worked till darkness brought the encounter to an end. The Burmans had about 40 light guns, while the British had, in vessels commanded by officers of the Royal Navy, 2 64-pounders, 12 25-pounder R.M.L. guns, 11 field guns, and 12 machine guns, served by blue-jackets and marines, while the Royal Artillery were provided with 28 pieces of ordnance, 6·3" howitzers, and 40-pounder rifled guns. Surely men were brave who worked the Burman light guns, all of small calibre, under the heavy fire of English artillery and riflemen. The art and practice of war that is taught in Europe differs from those in fashion in Burma. In Europe we commence firing at an exposed enemy two miles off with artillery, and nearly a mile off with rifles. Burmans do not fight in places where you can see such distances; they suit their method of fighting to the arms they carry. If you ask Burmans to form line and charge, they say at once, "That's folly; that's not fighting." They are very good at laying ambuscades, and delight in surprising an enemy; these they consider scientific warfare. To speak of bands of patriots or raiders as dacoits is not, I think, just. The effect seems to be to alienate sympathy from them. The term dacoit was introduced from India, where it has a technical signification, and is applied to members of a gang consisting of more than five robbers. Many of the bands of Burmans who were in arms against the British were no more to blame than the Scottish heroes of forays over their border.

Mr. Wm. Sherriff writes:—The paper is a grand record of progress since three years ago, when I appeared in this room to read a paper upon a kindred subject. Having experience of the splendid manner in which most of our officers went about their work in Upper Burma, the result, to me, is not surprising. The present, and almost complete pacification is due to the patient, steady, yet enthusiastic work of every British and native officer, from the highest to the lowest, whether civil or military, accomplished through good report and evil report—very much too much of the latter, as our gallant Chairman has justly remarked. Judging by the frequent and sometimes very extraordinary questions put to me, I can bear out Mr. White's statement that peace and order are now established to a degree not fully realised in this country. In 1889, I was unable to travel from the Irrawaddy 17 miles into the interior without a military escort, but now one may safely go along the same road, perhaps 170 miles, with no other company than native servants. I trust that in the near future we shall hear more of railway and road-making, and less of punitive and frontier expeditions. A subject in the paper of special interest to me is that dealing with the need of communications. In the history of public works under our Government, nothing, in my opinion, has succeeded—from every point of view—better than the extension of railway from Toungoo to Mandalay. A survey party has this month commenced to plan a further extension of the line through the Northern Shan States to Kunlung Ferry, on the Salween; and it is to be hoped that the building of the line will speedily follow. It is absolutely necessary, not only for the development of Burma and its dependencies, as for the increase of British trade with the south west provinces of China. The Board of Trade returns for last year, just published, show a falling off in our exports of over £20,000,000 sterling, a simple hard fact that tells a tale of woe concerning the great industries of this country. Road-making of every description is the most urgent necessity of Burma and the surrounding tributary States; but, with the continued drain of her surplus revenue to India, it is a moot question whether the time has not come for creating a separate administration for Burma, controlled by the Colonial-office, like Ceylon and the Straits. A variety of circumstances in the past rendered it expedient to place Burma as a province under India, although the two countries have little in common with each other.

Mr. Martin Wood writes:—In one brief paragraph Mr. White cited "a few statistics of the revenue of Upper Burma" since British occupation. These, as they stand in the paper, are apt to mislead those who are unacquainted with the history of that large transaction, or who may have forgotten the other side of the account. This is partly supplied in a Parliamentary return (No. 191) issued in May, last year. This shows, since 1886–7, the net expenditure

ncurred by our invasion and (as yet partial) subjugation of the kingdom; that is, after deducting the "revenue" amounts cited in the paper. These are the figures:—

	Rx.
1886-7	2,068,700
1887-8	2,618,300
1888-9	1,695,600
1889-90	1,333,900
1890-1	1,082,900
1891-2	1,267,000
1892-3 (budget)	1,205,000
	Rx. 11,271,400

There was also, in 1885-6, a net charge of Rx.605,000, and in the previous year there would be quite as large an amount. This shows that our acquisition of Upper Burmah has cost, up to date, over £12,000,000. Excess expenditure is still going on, so that, under the most favourable circumstances, there seems little chance of the conquest repaying the cost within the present generation; and it is specially important to remember that not one pound has been contributed by British funds, but the whole has to be sustained by the already almost exhausted finances of the Indian people. The political aspect of the subject was very forcibly touched upon by Mr. J. Annan Bryce, whose remarks will justly command attention, but they did not quite go to the root of the matter. It is instructive in this connection to recall the position held by the Marquis of Dalhousie, when, after the acquisition of Pegu, he was urged to go on to seize Upper Burma also. He stated his reasons against the course in a Minute, the draft of which he sent on to that eminent political officer, Colonel Sleeman, for his opinion. That shrewd man replied that the reasons given were good so far as they went, but that his lordship had left out the most weighty one of all. This, he proceeded to point out, was connected with the peculiar notions of the Burmese with regard to their king. "So long as the central monarchy remains," said he, "there will be some chance of the peace being maintained, that is, even in Lower Burma; but, if you destroy the native kingdom, everything will go wrong—chiefs and dacoits will rise all round, so that you will not be able to settle the country for 10 years to come." So Lord Dalhousie wisely left the Mandalay centre-piece alone, and the lower province was settled comparatively soon; but, on Thebaw's deposition, and the extinction of the Burmese dynasty, Sleeman's prescience was exactly confirmed, not only in Upper Burmah, as Mr. White's paper too slightly indicates, but dacoity broke out afresh in Lower Burma, as Sir Charles Bernard and others too well knew. Had one of the Alompra princes been retained, even only as a figure-head, the subjugation of Burma would have been a less disastrous and costly business; but it is too late, perhaps, to apply Sleeman's wise counsel.

SIXTH ORDINARY MEETING.

Wednesday, January 18, 1893; THOMAS RUPERT JONES, F.R.S., F.G.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Ault, William, Swadlincote, near Burton-on-Trent.
Bagster, Robert, 15, Paternoster-row, E.C.
Bond, Captain F. G., R.E., Bombay, India.
Brunton, J. Forrest, East India Tramway Company, Bunder-road, Karachi, India.
Douglas, Prof. James, 99, John-street, New York, U.S.A.
Firebrace, Lieut.-Colonel Frederick, R.E., Bombay, India.
Haite, George Charles, Ormsby-lodge, Chiswick.
Hughes, Arthur Saunders, Compton Knoll, Plymouth.
Lamont, Robert, Sturrock-street, Kilmarnock, N.B.
May, W. Costall, 1, Lansdowne-place, W.C.
Oertel, Frank Oscar, Lahore, Punjab, India.
Saltren-Willett, Lieut. A. J., R.A., Royal Arsenal, Woolwich.
Simkins, A. R., care of Fritz Otto, 21, Shaftesbury-road, Ravenscourt-park, W.
Walker, Frederick, 7, St. Cuthbert's-terrace, Black-hill, Durham.

The following candidates were balloted for and duly elected members of the Society.

Harwood, Arthur, Brighton-house, Heckmondwike, Yorkshire.
Knowles, C. J., Shaftesbury-house, Kensington, W.
Murch, Philip, The Town-hall, Portsmouth.

The paper read was—

THE MINING INDUSTRIES OF SOUTH AFRICA, AS SHOWN AT THE KIMBERLEY EXHIBITION.

By BENNETT H. BROUGH, Assoc.R.S.M.

The South African and International Exhibition was opened at Kimberley with great ceremony by Sir H. B. Loch, Governor of Cape Colony, on September 8th, 1892, and closed on December 8th. Though financially not as profitable as could have been wished, the Exhibition, from a technical point of view, was an unqualified success. At the time when the depression of trade was most severely felt, and workmen were thrown out of employment by the concentration of the diamond industry, it was suggested that an Exhibition would not only give a stimulus to trade and to labour, but would also serve to bring the industries of the various South African States and Colonies into closer connection. Thanks to the energy of the Executive Committee, under the able chairmanship of Mr. Davis-Allen, a mining

engineer of great experience, and to the facilities offered to excursionists by the Cape Government railways, the Exhibition was of such a character that it may fairly be considered the inauguration of a new period of prosperity for Kimberley. The rapid development of the mining, pastoral, and agricultural resources of the district, has created new wants for machinery and material which can be supplied by home manufacturers only, and it is a matter of congratulation that so excellent a collection of exhibits was got together at a centre 500 miles from the sea, as evidence that enterprising English manufacturers are still alive to the importance of securing the South African market.

The Exhibition was situated in the Kimberley Public Gardens, and covered an area of 30 acres. Like the whole of the town of Kimberley, it was built of corrugated iron; and, although no opportunity was afforded to the architect of investing the exterior with artistic beauty, the interior, thanks to a liberal display of bunting, was a mass of brilliant colouring. Besides the tastefully arranged exhibits, there were the gardens lit up with innumerable coloured lamps and with electric light, the firework displays, the illuminated fountains, good music, fine art collections, and the usual accessories of modern exhibitions. These were all novelties in South Africa, and afforded ample material to attract sightseers from all parts of the country.

It is not my intention to-night to describe the Exhibition, as its scope and character will be familiar to you from Mr. Lewis Atkinson's paper, read before this Society last year.* I merely wish to supplement that paper with some notes on the mining exhibits, which were amongst the most important and interesting of those in the Exhibition.

Among the mining countries of the world, South Africa, as is well known, occupies a prominent position. During a period of twenty years, it has unearthed and sold diamonds to the value of £70,000,000 sterling. From the discovery of gold in the Transvaal to the present time, a period of five years, there has been produced a value of some £8,500,000; and it is almost certain that the yearly earnings from gold mining will far exceed £4,500,000 per annum, without taking into account the new gold-producing districts being opened up in Mashonaland and Zoutpansberg. The coal-fields of South Africa are of vast extent, and the coal-mining industry is still in its infancy. Ores of silver and other metals occur in great abundance. The copper mines of Namaqualand, the produce of which, unfortunately, was not shown at the Kimberley Exhibition, yield some 20,000 tons of ore per annum. The existence of copper in this district was known as early as 1685, but want of fuel deterred the settlers from working the mines. The mineral resources of the country being so abundant, it was to be expected that in an African exhibition, the exhibits relating to mining would be of the greatest interest; and at Kimberley they justly occupied a prominent position.

The typical collection of minerals got together by Captain Quentrell, the Government Inspector of Mines for the Kimberley district, gave a good idea of the rich mineral resources of South Africa. Opportunity, too, was afforded of directing attention to those deposits which await further development, and which promise to open up a lucrative field for home capital. Indeed, this field seems to be inexhaustible, for although South African mining is so ancient as to have been carried on in prehistoric times, fresh discoveries of workable deposits are of constant occurrence. The great antiquity of South African mining was well shown by the interesting collection of archæological objects from Zimbabye in Mashonaland, collected by Mr. Theodore Bent, and described by him in his recently published work on the "Ruined Cities of Mashonaland." The Chartered Company, to whom the relics belong, provided in this exhibit matter for engrossing study. The most noticeable objects are the stone pillars carved with sacred birds, of which five were shown. The highest is 5 feet, the pillar, which is of soapstone, being 6 inches broad. On three out of the five pillars shown, the sculptured birds are comparatively uninjured. Other objects shown, of the same material, are a soapstone bowl, 3 feet in diameter, and 6 inches deep, hollowed out of one stone, a number of fragments of carved bowls depicting cows and human figures, crucibles for gold melting, moulds for gold ingots, a quartz crusher, gold burnishers, and a quantity of emblems of ancient worship. An excellent idea of the topographical features of Mashonaland was afforded by the large photographs of the country from the Shasti river to the Lundi, whilst there were six views of Zimbabye itself taken by Mrs. Bent, showing the walls of the fort 30 feet in height and 17 feet through, a passage between but

* *Journal*, vol. xl., p. 305.

3 feet wide, leading towards the central solid tower. The walls are built of small blocks of granite broken with the hammer to a uniform size, but bearing no trace of chisel marks, and no mortar had been used in the construction. The courses of small stones are carried out with surprising regularity, which shows that at the period when the buildings were erected there was an accurate knowledge of levelling and an unlimited supply of labour. The Phœnician origin of these remains appears to be shown by the moulds for gold ingots, the ingots having been cast in the characteristic "knuckle-bone" shape described by Diodorus Siculus 1900 years ago, exactly the same shape as that of the ingot of tin dredged up from Falmouth Harbour in 1811.

DIAMONDS.

As would naturally be expected, the exhibits relating to the diamond-mining industry were the most important, the chief attraction at the Exhibition being the diamonds shown by the De Beers Consolidated Mines. Among thousands of smaller stones, there were nine large ones, with a total of 1,562 carats, representing an aggregate value of £15,050, the most valuable stone being one of 292 carats, worth £3,500. The method of extracting the diamonds from their matrix was well shown by the complete washing plant lent by the De Beers Company. It was erected in a separate building adjoining the machinery-hall, and consisted of two elevators, pan, and pulsators. The whole was worked by a continuous process, so that, when the alloted quantity of ground was finished, the tailings were returned to the pulsator, and washed again, in order to illustrate the method of treatment, without allowing heaps of tailings to accumulate. The topographical features of the district were clearly shown by a large general plan of the diamond fields, on a scale of 10 chains to the inch, exhibited by the London and South African Exploration Company; and, in the machinery gallery, the principal appliances used in the diamond mines were displayed; a good idea could therefore be obtained of the present state of this great industry, and a visit to the Exhibition was rendered more instructive by the fact that the leading companies hospitably threw open their mines to visitors.

From the photographs projected on the screen, you will readily realise the high degree of perfection to which mining has been brought in the diamond fields. And, although these mines have frequently been admirably described,* a few explanatory words as to the method of working may perhaps not be out of place.

The four principal diamondiferous deposits at Kimberley, known as the De Beers, the Kimberley, the Bultfontein, and the Du Toitspan mines, occur in a circle three miles in diameter, and from this small area more than 90 per cent. of all the diamonds exported from South Africa are obtained. The deposits are evidently the result of the filling of extinct craters with volcanic mud from below. The matrix of the diamond is what is known as "blue ground," a breccia composed of shale, basalt, and diorite cemented together by olivine rock. As in other mineral deposits, the upper portion, which has been subjected to the action of atmospheric agencies, has become altered in character, and this weathered blue ground is known as "yellow ground." This material is what was worked in the early days, the appliances used being of the crudest character. The operations were conducted by the diggers working independently, and this state of things continued until the blue ground was reached. The bed-rock, as it was then called, having been struck, many diggers abandoned their claims; but it was soon found that the blue ground was in reality the original diamondiferous deposit. And the fact that it was more difficult and more costly to mine led to the extinction of the smaller holdings, and to the introduction of more rational methods of working. The mines, however, continued to be worked as open quarries until 1879, when the continued falls of rock from the sides of the excavations, and the constant influx of water, led to the idea of sinking shafts at the side of the mine, and of reaching the blue ground by underground galleries. As time went on, excessive competition among the various companies reduced the price of diamonds to the lowest ebb, and affairs began to look serious. Mr. Cecil Rhodes, and others associated with him, then

* Descriptions of the method of working are given in Mr. Gardner F. Williams's exhaustive technical report in the Second Annual Report of the De Beers Consolidated Mines, Limited, for the year ending 31st March, 1890; and in Mr. T. Reunert's contribution to the Cape of Good Hope Official Handbook. Useful information is also contained in M. A. Moulle's "Mémoire sur la géologie génerale et sur les mines de l'Afrique du Sud," Paris, 1885; and in M. E. Boutan's "Le diamant," Paris, 1886. The early history of the mines is discussed by Mr. J. N. Paxman ("Minutes of the Proceedings of the Institution of Civil Engineers," vol. lxxiv., p. 59) and by Mr. R. W. Murray (*Journal of the Society of Arts*, vol. xxix., 1881, p. 370).

conceived the idea of amalgamating the various companies. The steps in the achievement of this purpose, by the secret and steady purchase of shares by the De Beers Company have been so often described, that allusion to them is unnecessary. The complete amalgamation was, however, accomplished, and the De Beers Consolidated Mines, Limited, now owns, or controls, the Kimberley, the De Beers, the Bultfontein, and the Du Toitspan mines, and has acquired a preponderating interest in the chief outside mines. It, therefore, at the present time, controls the diamond trade of the world.

Except at Du Toitspan and Bultfontein, which, in order to lessen the production, were shut down in 1890, the mines are worked by means of shafts and levels. A good idea of the extent of the former open workings is obtained from the enormous excavations at these mines—great chasms, some 20 acres in area and 300 feet in depth. At the sides of the Kimberley mine excavation the black shale is seen burning freely. This is due to the presence of large quantities of carbon and iron pyrites, which ignite spontaneously. No burning shale exists in the De Beers mine, and no danger exists from the shale burning in the underground workings.

In the days of the independent diggers, the material was hauled in buckets from the depths below along wires that stretched down the chasm. Old photographs, an excellent collection of which were on view at the Exhibition, depict the huge excavations, in 1873, covered by a confused network of wires. This method of haulage can still be seen in operation at the North-East Bultfontein mine. The four wire ropes, serving as rails, are $1\frac{1}{4}$ to $2\frac{1}{2}$ inches in diameter, and are so inclined that the buckets can run down by their own weight when the engine is reversed. The hauling ropes are $\frac{3}{8}$ to $\frac{3}{4}$ inch in diameter. The steel buckets are hung on trunnions, and supported in a frame fitted with four grooved wheels which run on the bearing ropes. At North-East Bultfontein, in this manner, 6,000 tons of blue ground are raised per day by means of three hauling gears. The capacity of the buckets is 35 cubic feet, and the gauge of the ropeway is 4 feet 6 inches, there being a double way with 20 inches intermediate space.

At Kimberley and De Beers mines, where shafts are employed, winding and pumping machinery of the most improved type is in use. At the Kimberley mine the vertical shaft begun in March, 1889, is now 1,261 feet down, the blue having been struck at a depth of 1,000 feet at a distance of 1,134 feet from the shaft. The last 485 feet in quartzite was driven by the aid of rock-drills in 26 weeks, a speed twice that attained by the hand labour previously used. The shaft measures $20\frac{1}{2}$ feet by 6 feet.

At the De Beers mine, winding is carried on at a surprising speed. The No. 2 incline shaft has a vertical depth of 700 feet, or, as the inclination is 56° from the horizontal, 840 feet on the incline. The skips, which run on steel rails, and are so arranged as to tip automatically, hold 64 cubic feet or four loads weighing 1,600 lbs. each. As much as 400 loads have been raised within an hour. The vertical rock shaft, which measures 20 feet by 6 feet, drains the mine at a depth of 800 feet. At this shaft pumping and winding machinery of the most modern type has been installed. The head-gear is of wrought-iron girder work, the height from the ground to the centre of the pulleys being 61 feet. There are three 14 foot pulleys, with cast-iron rims and bosses and wrought-iron spokes.

On reaching the surface the contents of the skips are tipped automaticaly into bins, from which the blue ground is filled into steel trucks running on a tramway of 18 in. gauge. These trucks are conveyed to the depositing floors by an endless chain haulage. On the floors, light locomotives are used for transporting the trucks. There are seven such locomotives at the Kimberley mine, and three, together with 370 horses, at De Beers. At De Beers, instead of endless chain haulage, a more elaborate system of wire rope haulage is employed, some five miles in length. On the floors, where a hard and level surface is prepared, the blue ground is allowed to disintegrate by means of atmospheric agencies. The material is spread to a thickness of 9 inches, ploughed and harrowed, the weathering action being facilitated by an occasional sprinkling with water in the dry season. The floors have an area of several square miles, and contain a million loads of blue ground. The weathering action is allowed to continue for a year. Even at the end of that time there is some 10 per cent. of the material that is not acted on, being so hard that it has to be crushed by a stone breaker.

When the disintegration is complete, the material is taken to the washing gear, where it is raised by means of a lift, and deposited in the hopper, whence it passes through a shoot into a rotating cylindrical screen of one-inch mesh. The lumps pass out for further weather-

ing, whilst the pulverised blue ground passes into an annular pan, 14 feet in diameter, with revolving arms and teeth, water being supplied by perforated pipes. In this pan the heavy deposit is carried towards the outside rim, whilst the lighter material, flowing towards the centre, is discharged into the tailings pit, and thence carried to an adjoining heap by elevators. The diamonds, garnets, and other minerals of high specific gravity, settle at the bottom of the pan, and are drawn off from time to time, and conveyed to the pulsators in locked trucks for further concentration. The pulsators are exactly similar to the jigging machines with which all miners are acquainted. They are provided with sieves of various meshes, and with a bed of leaden bullets, which prevent the deposit from passing through the sieves too rapidly. The heavy deposit, containing the diamonds, passes through the screens into pointed boxes, whence it is taken to the sorting tables; the lighter refuse flows away. The sorting is conducted in a long shed, first, when wet, by skilled workmen, and again, when dry, by native convicts, the process being repeated as long as sufficient diamonds can be found to repay the cost of convict labour.

Electric lighting is used, both at surface and underground, the greater part of the levels and the main ladder-ways in the mines being illuminated in this way.

The largest diamond found weighed 428½ carats.* This was stolen from the De Beers mine by a native, but subsequently recovered. The illicit traffic in diamonds is the greatest difficulty the company has to contend with. The natives are, consequently, subjected to a most careful examination; but, in spite of every precaution, they still manage to steal a certain quantity of diamonds, concealing them chiefly by swallowing them. The greatest weight ever swallowed at one time amounted to 70 carats. Thefts of late years have been largely diminished by keeping the native miners strictly confined in compounds, for the period of their agreement with the company. These compounds consist of rows of one-storied corrugated iron buildings placed round four sides of a large square, which is surrounded by a wall 10 feet high, and guarded by warders. Within the compound is a store, where all necessaries of life are supplied, food, wood, and water being furnished free of charge. Swimming baths, post-offices, and hospitals are connected with the compound. Intoxicants are rigidly excluded, and gambling is forbidden. The natives are thus better housed and fed than they have ever been before, and they seem to be thoroughly contented.

The white *employés* are also well looked after, every provision being made for supplying them with all the comforts of civilisation. The model village of Kenilworth, now being erected by the company, with its pretty houses and gardens surrounded by trees, forms a perfect oasis in the desert; whilst Kimberley itself is provided with a magnificent hospital, a free library, and other public institutions. In fact, Englishmen have every reason to be proud of this South African town as worthily representing our nation.

The extent of the operations of the De Beers Company will be readily seen from the statistics given in the Table on p. 171.

Next in importance to the four great mines of the De Beers Company, to which reference has been made, is the Wesselton mine, which was not discovered until the end of 1890, although it is situated within a mile to the east of Du Toitspan, on ground that has been prospected in all directions within the last twenty years. The absence of the ordinary surface indications led to its being overlooked. It lies in a slight depression, and is covered by some 12 feet of limestone, whilst most of the other mines were originally *kopjes* or hillocks. The owner of the estate, Mr. H. A. Ward, has sold the property to the De Beers Company for the sum of £303,000. Mr. Ward's part of the agreement further gives him the right to mine 5,000,000 loads of yellow ground in the five years, 1892 to 1896, and out of the proceeds he has to pay back to the De Beers Company half the purchase price and interest on the whole at 9 per cent. per annum. He is also bound not to sell more than 20,000 carats of diamonds per month. By this bargain it is estimated, by Mr. Reunert, that Mr. Ward will make half a million sterling.

The Wesselton mine is of special interest, inasmuch as the workings are confined to the yellow ground, and the visitor can thus readily picture the conditions which must have obtained in the Kimberley mines in the early days. The mine is, of course, worked entirely by quarrying. The deposit is the second largest of the local group, Du Toitspan taking the first place.

The process of working the yellow ground is much simpler than is the case with the blue. No preliminary weathering is required. The

* A carat weighs 3·17 Troy grains.

TABLE OF STATISTICS OF DE BEERS CONSOLIDATED MINES, LIMITED, SINCE ITS FORMATION, 1ST APRIL, 1888.

Year ending	Number of loads of blue hoisted	Number of loads of blue washed	Number of carats of diamonds found	Amount realised by sale of diamonds. £ s. d.	Number of carats per load of blue.	Amount realised per carat sold. s. d.	Amount realised per load. s. d.	Cost of production per load. s. d.	Balance of loads of blue on floors at close of year.	Dividends. Date.	Dividends. Amount. £ s. d.	Dividends. Equal to p. c.	Capital. £
March 31, 1889 prior to Consolidation.	944,706	712,263	914,121	901,818 0 5	1·283	19 8¾	25 3¾	9 10½	476,403	Dec. 31, 1888.	188,329 10 0	5	3,937,050
March 31, 1890	2,192,226	1,325,400	1,450,605	2,330,179 16 3	1·09	32 6¾	35 7½	8 10½	1,576,821	June 30, 1889. Dec. 1, "	394,786 10 0 394,895 10 0	10 10	3,947,865 3,948,955
March 31, 1891	1,978,153	2,105,182	2,020,515	2,974,670 9 0	0·96	29 6	28 4	8 8	1,449,792	June 30, 1890. Dec. 31, "	394,895 10 0 394,895 10 0	10 10	3,948,955 3,948,955
June 30, 1892	3,338,553	3,239,134 and Dutoitspan and Bultfontein 454,278	3,035,481	3,931,542 11 1	0·92	25 6	23 5	7 4·3	1,624,803	June 30, 1891. Dec. 31, " June 30, 1892.	394,895 10 0 493,619 7 6 493,619 7 6	10 12½ 12½	3,948,955

yellow ground is hauled direct to the six washing machines by six hauling gears, tipped into a hopper, thence passing into a rotating cylinder with one-inch mesh. The fine material passes through into the circular pans, which are supplied with water pumped from the mine, and the lumps coming out of the lower end of the cylinder are set aside for further treatment. The mud from the washing pans is carried away by means of elevators to the waste heaps. The deposit is uniformly diamondiferous, and blue ground is encountered at a depth of 90 feet. The top yellow ground, down to a depth of 65 feet, yields 27 carats per 100 loads. The diamonds, as was clearly evident from the specimens shown at the Exhibition, are of the highest quality, and are readily marketable.

Within the Orange Free State, there are several diamond mines, but none has attained the success of the Kimberley mines. The best mine, Jagersfontein, was well represented in the Orange Free State Court of the Exhibition. A valuable collection of diamonds, specimens of the blue ground, and of other rocks, and a series of excellent photographs clearly showed the nature of the deposit, and the manner in which it is worked. The Jagersfontein diamonds are nearly 30 per cent. better in quality than those of De Beers, but the average yield is very much less, that of De Beers being 1 carat per load, and that of Jagersfontein 0·11 carat per load. The mine is worked entirely as an open quarry, the lowest workings being 300 feet in depth.

In addition to the diamondiferous deposits described, alluvial deposits are also worked, but on a much smaller scale. These "river diggings" extend from Delport's Hope, at the junction of the Vaal and Harts Rivers to above Hebron on the former river, a length of some 70 miles, the centre being the town of Barkly West, 75 miles north-west of Kimberley. The diamonds occur in an alluvial soil consisting of a heavy deposit of ferruginous gravel mixed with red sand, lime and boulders, which has been washed into crevices in the rock by floods. Most of the diggings are very shallow, but at Gong Gong shafts had to be sunk for 100 feet before the bed-rock was reached. The amalgamation of the diamond mines has resulted in an increase of activity at the river diggings, and there are now about 1,000 white men, besides native labourers engaged. The appliances used are of a primitive description, and though a fair return would seem to

be yielded to hard-working individuals, the results do not justify the outlay of much capital. The character of these river diggings was well shown at the Exhibition by Messrs. Hill and Paddon's complete collection displayed in the mineralogical department. A series of glass globes were shown filled with gravels and pebbles from the bed of the river from which the diamonds are obtained. Specimens were collected all along the Vaal River from Barkly West to Harts River, the collection including specimens of the deposits from the Newland's mine, and of the top soil and deep level formation of Niekerk's Rush and Gong Gong.

Comparing all available sources of information, it is confidently asserted by Mr. T. Reunert that the Cape Colony has exported, from the discovery of diamonds in South Africa, in 1867, more than 50,000,000 carats of diamonds, of a total value of nearly £70,000,000 sterling. The diamonds exported have weighed over 10 tons, and, if piled in a heap, they would form a pyramid 6 feet high, with a base 9 feet square.

Gold.

One of the most interesting exhibits in the mineralogical department of the Exhibition was that of the Walker Prospecting Syndicate. It consisted of specimens of auriferous quartz from the veins of Barkly West. The existence of deposits, bearing gold in payable quantities, within easy reach of Kimberley, is not generally known; yet, if we may judge from the specimens exhibited, this deposit is one deserving attention. It seems difficult to understand why this property has remained so long unworked, as there are no difficulties in the way of water supply or transport, and fuel and labour are easily obtainable. The vein is stated to have a width of 11 feet, and the percentage of gold obtained on trial crushings is perfectly satisfactory. Some 25 tons of ore from this vein, at a depth of 100 feet below the surface, was supplied for treatment in the gold extraction plant working in the Exhibition.

The peculiar and interesting district of the Witwatersrand, the richest goldfield in South Africa, was not so fully represented at the Exhibition as could have been wished. A clear idea of the enormous output of the mines of this district was given, however, by the trophy exhibited by the Johannesburg Chamber of Mines. This trophy stood in the main building, and was in the form of an obelisk, made to resemble gold. On it were plainly marked divisions showing the annual outputs from the Rand mines since 1888 to the end of August, 1892. The output of 1888 was about one-tenth of that of the eight months of 1892; about one-sixth of that of 1891; one-fourth of that of 1890; and one-third of that of 1889. It is thus evident, not only that the quantity of gold raised is increasing, but also that gold-mining has become a permanent industry in the Transvaal. According to the figures published by the Johannesburg Chamber of Mines, the gold production of the Rand since 1888 has been as follows:—

	ozs.
1889	370,408
1890	494,817
1891	729,238

According to telegraphic advices, the total for 1892 amounted to 1,210,867 ozs., an increase of some 66 per cent. as compared with the production of the preceding year. Nor has mining in the Transvaal yet reached its culminating point, as new mines are constantly being opened and old ones developed. The difficulties of transport have been obviated by the opening of the railway to Johannesburg, and the other causes tending to hinder the development of the gold-mining industry—the excessive taxation and the inflated price of labour—are likely to be removed.

The latest detailed monthly statistics available show that the Rand mines, in November last, produced 106,794 ounces, valued at £377,687. The quantity of ore stamped was 179,745 tons, 2,004 heads of stamps being in operation. The average amount pulverised per stamp per day was 3·62 tons, and the average return over the plates was 9·24 dwt. of gold per ton, valued at 33s. 4d. The gold output is subdivided in the following manner:—

	ozs.
From the stamps	83,802
,, concentrates	3,647
,, tailings	15,346
Alluvial	245
Other sources	3,854

At Johannesburg the supply of white labour is in excess of the demand. Native labour, on the other hand, is obtained with difficulty. Some 15,000 natives are at present employed, 58 per cent. coming from the East Coast, 19 per cent. from the north of the Transvaal, 12 per cent. from Basutoland, and 11 per cent. from Zululand. The average stay of a Kaffir on the goldfields is under six months.

The geological structure of the Rand was

clearly shown by a well-executed geological map, exhibited by Mr. H. E. Simpson. In the Witwatersrand there are now more than 70 mines, the workings extending from east to west for a distance of 40 miles. The gold occurs in so-called reefs, which are in reality true conglomerate beds. Of these there are four, the most important being the main reef, which is the thickest and least coherent. The pebbles in this conglomerate are half an inch to two inches in diameter and consist of quartz, the cementing material being silvery grey micaceous matter, containing the greater portion of the gold. At depths to which atmospheric agencies can penetrate, the conglomerate is of chocolate brown colour, but at greater depths, when unchanged, it is of a blue colour and crowded with crystals of pyrites. The dip of the main reef at the Salisbury mine is 85° S., and the strike east and west. The deposit varies much in character at different points. At the Ferreira mine, for example, it is much faulted and very irregular, whilst at the Crown Reef mine it is as regular as an ordinary coal seam.

The various mines of this district have been so ably described in works dealing with the Transvaal and in the technical press, that it is unnecessary for me to repeat the information already published. I shall therefore content myself with showing you a series of photographs, illustrating the methods of mining in vogue. The original workings on the outcrop were conducted in a very primitive manner. It was thought that the Rand auriferous conglomerate was so unlike other mineral deposits, that experience in other mining districts was not an essential qualification for a manager, and consequently men who had never previously seen a mine, readily obtained responsible positions. In fact, the mines were started as our grandfathers would have started them—without the slightest knowledge of recent progress in mining science. Happily, different conditions now prevail. The competition for responsible positions is very keen at Johannesburg, and among the managers directing the larger mines are to be found some of the most skilful mining engineers of the day. The result is that the Ferreira mine, for example, the best managed mine in the district, notwithstanding the difficulties in mining due to the irregular character of the deposit, pays dividends of 125 per cent.

At this mine the width of the deposit varies from 15 inches to 3 feet. There are two main shafts, 14 by 5 feet, going down vertically to depths of 220 and 257 feet respectively, and then sunk on the incline of 78° to a depth of 420 feet. The deposit is worked by underhand stoping, as by this method it is found easier for the unskilled native miners to bore holes for the reception of explosives. The cost of mining decreased from £1 9s. 8d. per ton of rock, in April, to 17s. 2d. in September last. The stamp battery is situated half a mile from the mine, and is connected with the pumping station by 2,000 feet of piping, the reservoir containing 25,000,000 gallons of water. The stamps are of American design, and treat 4·44 tons per day, the average yield being 15 dwt. of gold per ton. From 66 to 68 per cent. of the gold is saved, whilst the tailings are treated by the cyanide process.

At the Robinson mine, where there is a 60-stamp battery pulverising 4·65 tons of ore per stamp per day, the extraction of the gold from the ore is conducted with surprising results. The proportion of gold recovered is 94·82 per cent., the share taken up by each of the three processes adopted being as follows:—

	Per cent.
Stamp battery (ore)	71·04
Chlorination (concentrates) ..	5·13
Cyanide process (tailings)	18·55

At the chlorination works, the concentrates are placed in heaps, carefully labelled, in the sampling shed. The proportion of pyrites in the concentrates varies from 5 to 90 per cent. The different lots are therefore made up into a suitable mixture for roasting, the percentage of sulphur being kept low. The mixture is then trammed into the roasting furnaces, of which there are three, each 60 feet in length, treating 600 or 800 tons per month. When roasted, the material is charged into 10 circular chlorination vats, with bottom discharge, and luted rings and lids. The chlorination occupies four days, 6 lbs. of chlorine, or 0·6 per cent. for each ton of concentrates being used. A precipitating solution of ferrous sulphate is employed, the mass being kept agitated by means of a jet of compressed air. The consumption of ferrous sulphate amounts to 10 to 15 lbs. per ton of concentrates. The waste liquors are run into vats, and cleaned up four times a year.

At the cyanide works there are 12 large vats, each of 2,000 cubic feet capacity, holding 75 tons of tailings and 25 tons of cyanide solution. Below the false bottom and filtering layer of matting in each vat there is a discharge orifice. When the vat is filled with tailings, the cyanide

solution is pumped in, and in a day's time the gold is all dissolved. The auriferous solution is then run off into long narrow boxes filled with fine zinc shavings. The gold is here precipitated in the form of black mud, which is run down in four furnaces. The works are able to deal with 7,700 tons of concentrates per month. The chemistry of the cyanide process, as applied at the Robinson mine, has been fully discussed by Mr. C. Butters and Mr. J. E. Clennell (*Engineering and Mining Journal*, 1892, vol. liv., p. 341).

The results of the treatment of the ore at the Robinson mine last month (December, 1892) were as follows:—The 60 stamps pulverised 7,958 tons of ore, the gold yielded on retorting being 8,238 ozs. The tailings treated by the cyanide process yielded 1,517 ozs. The concentrates treated by the chlorination process yielded 763 ozs., whilst purchased concentrates from other mines gave 4,047 ozs. The total output of gold from Robinson ore during the month was thus 10,518 ozs.

The Witwatersrand was not the only gold-producing district of the Transvaal represented at the Kimberley Exhibition. An obelisk in the Transvaal Court served to show the output from the famous Sheba reef. The obelisk was 103 inches high and 13 inches square, representing a weight of 100,525 ozs. 4 dwt. 2 grs., or 3 tons 1 cwt. 2 qrs. 5 lbs.; the product obtained from 57,733 tons of gold quartz averaging 1 oz. 14 dwt. 20 grs. of gold per ton of ore. This mine is situated near the town of Barberton, in the east of the Transvaal, the district that attracted the first rush in 1885. The district is exceedingly mountainous, and the miners have to contend with very great difficulties, the greatest being the lack of water and timber. The manner in which the difficulties of transport have been overcome, by the construction of an aërial Otto ropeway $2\frac{3}{4}$ miles in length, with a capacity of 150 tons per day of 10 hours, over inclines as great as 1 in 1·6, and over spans as great as 1,480 feet, was well shown by an excellent series of photographs exhibited; whilst the accompanying series of specimens clearly showed the richness of the deposit and afforded an insight into the geological structure of the De Kaap district. The base of the district is a syenite-granite, exposed over the whole of the low-lying surface of the De Kaap valley. By the decomposed state of its surface, it shows for how long a period it has been subjected to sub-aërial denudation. Resting on this granite base is a series of quartzites and slates, folded into mountain ridges until the upturned beds are nearly perpendicular. Dykes of diorite burst through these rocks, and form sharp ridges. The auriferous deposits of the district are of two kinds—(1) the interbedded massive quartzites, which, in places, are auriferous, and (2) fissures, caused by the fracture and shrinkage of the stratified rocks, filled in with auriferous quartz.

From the Zoutpansberg goldfield some fine specimens of white auriferous quartz from the Swiss reef were shown by the Silati River Gold Mining Company. The reef is 3 to 5 feet in width, and carries from 1 to 5 oz. of gold per ton.

The goldfields of the Lydenburg and the Murchison Chain districts were not represented at the Exhibition. Matabeleland, however, was well represented by an attractive exhibit of minerals and anthropological objects from the Tati concession, the exhibit including a mass of 603·7 ozs. of retorted gold from the Monarch reef. This concession was granted by Lo Bengula, in 1880, to a Kimberley company, and was transferred, in 1888, to the Tati Concession Company. The tract of country included in the concession is situated between the Ramakabane and Shasi rivers, and covers an area of 2,000 square miles. It includes all the veins discovered in the district of late years, together with many of those observed by Mauch and Baines in 1886. Though these deposits were known more than a quarter of a century ago, no sustained work had been done until the formation of the second company. The district is of historical interest, in that the lodes appear to have been worked in a primitive manner at an unknown period.

The total gold output of the Transvaal, in 1891, is summarised by the Witwatersrand Chamber of Mines, as follows:—

	Ozs.
Witwatersrand	729,238
De Kaap	66,598
Lydenburg	23,903
Zoutpansberg	7,926
Klerksdorp	10,682
Total	838,347

This total represents 13·8 per cent. of the world's yield. In 1888 the Transvaal produced only $4\frac{1}{2}$ per cent. of the world's production.

Coal.

At the Kimberley Exhibition coal was not forgotten. The coal-mining industry of South

Africa is assuming large proportions, and many of the samples of coal shown were of excellent quality. Kimberley is not so fortunate as Johannesburg in having coal on the spot, nor is it is direct railway communication with the colonial coalfields. The production of the Cape Colony coalfields in 1890 was as follows:—

	Tons.
Cyphergat	11,000
Molteno	5,821
Sieraadsfontein	6,000
Fairview	8,000
Indwe	2,200

Large quantities of Indwe coal were shown at the Exhibition by Messrs. Reunert and Lenz. The coal occurs in thick seams, easy to work, whilst at the Cyphergat and other Stormberg mines the seams are narrow, and cost three times as much to mine.

In the Transvaal the coal, which occurs in close proximity to the gold deposits, exists in lenticular beds, varying in thickness from a few inches up to 30 feet. In the Orange Free State the coal strata probably constitute much thicker deposits and cover larger areas. The most important colliery in the Transvaal is 20 miles from Johannesburg, and is reached by the narrow gauge railway, the Rand tram, which runs east and west alone the main reef. The seam is 21 feet in thickness and is mined in a thoroughly systematic manner, the colliery being illuminated by electric light and screening machinery of modern design being employed. There are 2,500 acres of coal, 20 feet in thickness, available. Two rectangular shafts, 98 and 130 feet in depth respectively, afford access to the workings, which are conducted on the pillar and stall system. There are also several ventilating shafts, and inclines by which the native workmen enter the mine. After having been screened, the coal is placed in sacks and transported by railway to Johannesburg. The production of coal from this colliery, in 1891, amounted to 70,241 tons. The cost of working is 6s. per ton, and that of transport to Johannesburg is 8s. The cost of transport is probably increased by the barbarous system of conveying in sacks, as each costs 1s., and lasts for not more than four trips. The Natal coalfields were not represented at the Exhibition. This is to be regretted, as the coal-measures cover a large area in the north of the colony, and the coal is of very good quality, and can be very cheaply worked. The annual production of the colony is about 54,000 tons.

The value of South African coals is shown by the following results of some recent careful comparative tests of British and South African coal:—

Kind of Coal.	Lbs. of Water Evaporated per lb. of Coal from 212° F.	Per-centage Value, taking British Coal at 100.
Vaal Drift, Transvaal	5·28	49·12
Newcastle, Natal	9·24	85.96
Indwe, Cape Colony	7·09	65·95
Lewis and Marks, Transvaal	6·73	62·64
Newcastle, Natal (2)	8·52	79·26
Kroonstad, Free State	7·08	65·89
Welsh Colliery, Natal	8·26	76·87

The British coal taken as standard was Nixon's Steam Navigation coal, which gave 10·75 lbs. of water evaporated. The tests were made from time to time at the Beely boilers at the De Beers diamond mine.

Other tests, details of which have been published (*South African Mining Journal*, vol. i., p. 96), gave the following results:—

Coal.	Water evaporated.	Per-centage value.
Good average British	9·0	100
Oliphant's River	7·1	81
Steenkool Spruit	6·9	79
Anglo-African	6·7	77
Newcastle, Natal	6·7	77
Brakpan	6·1	71
Black Diamond	5·0	60
Holdfast	4·2	52
Vogelfontein	3·3	43

Miscellaneous Minerals.

Besides diamonds, gold ore, and coal, many other minerals of less importance were shown at the Exhibition. There was, of course, the inevitable display of crocidolite from Griqualand West, so familiar to visitors to all recent exhibitions. Of this mineral some £2,000 worth is exported annually. There were also some fine specimens of galena from the Maitland Mines, near Port Elizabeth, obtained from a depth of 50 feet, and yielding, on assay, 67 per cent. of lead and 18½ oz. of silver per ton. Samples of salt were exhibited by

the Zwartkops Saltpan Company, whose output in 1890 amounted to 82,282 bags (of 180 to 200 lbs.). In the Bechuanaland Court, copper ore from the vicinity of Vryburg was shown, and in the Orange Free State Court, besides other minerals, there were some excellent specimens of raw sienna from Philippolis. Some specimens of Cape ochre made into cake water-colours, exhibited by Mr. A. de Smidt, of Southampton, suggested that diligent and intelligent search for such pigments will produce an interesting and profitable addition to the already abundant mineral resources of South Africa.

A description of the interesting collection of mining material and machinery exhibited by home makers in the Machinery-hall, under the able direction of Mr. H. D. Griffiths, the Exhibition engineer, is beyond the scope of this paper.

Financially, the Kimberley Exhibition was not successful, the accounts showing a deficit £14,195. An international exhibition in a sparsely populated region remote from the sea was, in many respects, a venture. There was a considerable amount of uncertainty about its prospects, and the promoters were content to meet possible disappointment. Notwithstanding the fact that, owing to local rivalries but very slight aid was received from other towns in the colony, it cannot be denied that the Exhibition was a thoroughly good and representative one. This sketch of the more important mineral exhibits will, I trust, show that the mining section at least was worthy of a town that has had sufficient enterprise to organise an international exhibition in South Africa.

The paper was illustrated by lantern photographs of the Kimberley Exhibition, the Kimberley, De Beers, Du Toitspan, Bultfontein, and Wesselton diamond mines, and of the Ferreira, Langlaagte, and Robinson gold mines.

DISCUSSION.

The CHAIRMAN said this was a most interesting paper, and no doubt, if Mr. Brough had had more time, he could have given even more information. He had been very much pleased with the clearness of the descriptions of the various mining industries, and still more with the technical accuracy in the use of terms; there was no confusion between veins and seams, such as one often heard. He must protest against the use of the word "diamondiferous," which was quite contrary to the genius of the language; and, though it was common in the colony, he hoped it would be discontinued. What had been said about the blue ground was very interesting, and no doubt Mr. Brough could have said something as to the theory of its origin, beyond the mere fact of it being found in the craters of extinct volcanoes. The widespread extent of gold-bearing ground was also a matter of great interest.

Prof. C. LE NEVE FOSTER, F.R.S., said he was hardly qualified to speak on these South African deposits, as his experience of Africa had been confined to the north; but he had read a good deal about them, had mixed so much with people who had visited them, and had described them so frequently to his class of mining students, that he almost began to believe that he had actually been there. It might be interesting to the members to know that the first Government Inspector of Mines in the district was aided by the Society, more than 25 years ago, to visit the Paris Exhibition and report on the mining exhibits. Since then he had left the Colonial Service, become a well-known manager in Kimberley, and was now one of the directors of the great De Beers Company. Mr. Brough sent a thrill of envy through the British mining engineer, in describing the beautiful ladder-ways in Kimberley lit by electricity, instead of by the tallow candles which were used in this country; and he did wonder that some of the ladder-ways and man-engines in England were not illuminated in similar fashion. In the case of a man-engine going down 200 fathoms, 100 incandescent lamps would be sufficient to light it, one at each platform, and the riding on these man-engines would be much safer and more comfortable if this plan were adopted. Some British miners might also envy the compounds in which the native miners lived; he was quite sure, from what he had heard and read, that these men were better housed than some of the miners in North Wales. He should like to ask how the per-centage of gold extracted at the Robinson mine—94·8 per cent.—was arrived at. It was a very large proportion, and though it was explained that there were three processes, part being got out by the battery, part by chlorination, and part by the cyanide process, he should like to know how the exact per-centage was calculated. The quantity of concentrates treated was very large, and he should like to know what proportion it bore to the total quantity stamped. Both as citizens of the United Kingdom and as geologists, they had a deep interest in these discoveries in South Africa. Geology had been enriched by a knowledge of diamond-bearin deposits unknown to science and unsuspected 25 years ago; and although they knew of gold in the conglomerates, they were unaware of such extensive gold-bearing conglomerates as those which were now being worked with such success. As citizens, they must feel the wonderful effect these discoveries, springing as they did from such a small beginning, were having on the empire. That beginning was the accidental finding of a diamond in 1867. This gradually led to the working of these wonderful deposits of Cape Colony, a place then littl

thought of but now increasing in importance rapidly. The diamonds had led to the discovery of gold in the Transvaal; Englishmen were now going still further north, and there was no telling what would be the ultimate effect of these discoveries on the British Empire.

The CHAIRMAN remarked that there was a deposit of blue ground at South Kensington. It was left at the time of the Colonial Exhibition, and was carted off as rubbish to form part of the foundation of the road in front of the Imperial Institute.

Mr. NICOL BROWN said he was somewhat interested in the Lydenburg district. It had been of very slow development, and, owing in great measure to the absence of any geological survey of the country, the company had to make their own surveys. It was a long time before they discovered that the place where the reef was to be found was at the junction between the limestone and the quartzite. A great many intrusive divisions came in through cracks in the rock, and cut off the connection between one part of the vein and the other, and, in consequence, it was at first very difficult to follow. But after mines had been opened out at different parts, it was found that the general dip of the rocks was from west to east, and by taking the veins, which had been named according to the Greek alphabet, as they were met with along the cropping of the whole, it could be seen that the dip had a pretty regular angle of about 30°. It was a long time before this was found out, and now it was expected that by the use of this fact many more discoveries would be made. Although the general dip was from west to east, the local dip was often from north to south, but this would only affect an area of perhaps a few hundred feet, or an upthrow of 50 feet. The mines had been worked by the Transvaal Gold Exploration Company for ten years, but only within a year or two had this regular dip been proved. The manager of the mine, Mr. Spiers, was present, and might be able to add some further information.

Mr. SPIERS said he could not say much except to corroborate what Mr. Brown had stated, as to the stratum being found between the quartzite and limestone bed. It was very much broken up in places, but they had been able to trace it many miles, and in some parts it was a considerable thickness, from 5 feet up to 12 feet, and the thickest part was the richest. In many parts it was very thin, and though auriferous, was not payable.

Mr. OLIVER WILLIAMS asked how far the natives were allowed to leave the compound; it would almost seem, from the description, as if they were prisoners, but of course he knew that was not so. Some friends of his were interested in Mashonaland, and he had recently seen three telegrams from there which might be of interest. One spoke of a case in which 14 tons crushed yielded over 14 oz.; another of 12 tons crushed which yielded over 23 ozs of gold; and the other mentioned three blocks having recently been pegged out, containing forty claims in the chartered territory, about forty miles west of Fort Victoria, with outcrops of gold throughout, the assays of which yielded 2 ozs. per ton.

Mr. BROUGH, in reply, said he was much complimented by the kind way in which the Chairman had spoken of the paper, and he would promise never to use the word "diamondiferous" again. He had a difficulty in answering the questions which had been propounded. With regard to the per-centage of gold recovered at the Robinson mine, he could only say that he believed the results to be based on calculations of the assays of the original ore and of the tailings. The large amount of concentrates alluded to was due to the fact that the Robinson mine treated concentrates purchased from other mines. With regard to the natives leaving the compound they were only kept in confinement for the time of their agreement with the company, which generally lasted from three to six months; and they then went back to their own homes. Sometimes they came back again to make a second fortune. With regard to the gold in the Transvaal, there was a long article in the *Times* of Tuesday, from the pen of Mr. Hamilton Smith, the leading expert on the subject, in which he discussed the possibility of mining those deposits at great depths; and the result of his estimates was, that the gold resources of the country amounted to £325,000,000 sterling. This huge figure was by no means a wild conjecture, but the result of very careful study; for he had an opportunity of seeing the exhaustive manner in which Mr. Smith made his investigation, working early and late, and visiting every mine in the district. He believed, therefore, that these figures might be accepted with confidence. California, which contained an enormous quantity of gold, in the 42 years during which mining had been carried on there, had yielded only £230,000,000, so that Mr. Smith's figures would give an idea of the extraordinary richness of the few square miles embraced in the Witwatersrand. This was a very difficult subject to deal with in a short time, and his visit to South Africa was only a vacation trip, so that he could not pose as an authority. He had an opportunity of carefully studying the Exhibition at Kimberley, but his experience of the Transvaal and the Orange Free State was confined to very hasty visits; still he hoped that his few notes would indicate that the Exhibition was a good one, and would give some notion of the vast resources of a country which was now producing 95 per cent. of the world's supply of diamonds, and 20 per cent. of the supply of gold.

The CHAIRMAN then proposed a vote of thanks to Mr. Brough, which was carried unanimously, and the meeting adjourned.

Miscellaneous.

PRODUCTION OF JOHORE TEA.

The United States Consul at Singapore says, that the Sultan of Johore, in his work of developing his country's resources, has gone outside the natural products of the soil, and has experimented with staple productions that are native to other sections. In coffee, tea, and pepper, his experiments have proved so far successful that to-day they comprise the chief output of his kingdom, surpassing in value the native products of the soil—sago, tapioca, cocoa, pineapple, gambier, spices, and gums. Especially in regard to tea has the soil proved efficacious, giving it a delicious odour and flavour, that, to the taste of many connoisseurs, place it ahead of the original Assam or the famons Ceylon. The Michaelstowe tea-gardens, in the Sultan of Johore's territory, have an area of 800 acres, of which 165 acres are under cultivation. The gardens are situated on the River Scudie, twenty-five miles from Singapore, by water, and eight miles, by road, from Johore. They are planted with Assam hybrid, which in the moist and steamy climate "flushes" all the year round. The leaves plucked are the young shoots, the bud, and the small leaves next to it only being pinched. As these are picked off, fresh shoots are thrown out, and in about eight days are ready for plucking. These young shoots are called flushes, and, on the average, each bush flushes three times a month. In about a year the bush flowers, and must be pruned, that is, the shoots are cut back, which stops the picking for six weeks or so, but gives time for the bush to increase in size and flushing power. The bushes are planted 5 feet apart in rows also 5 feet apart. Chinese, Javanese, and Malayan labourers are employed, and it is found that the most rapid and skilful pluckers are the women and children. The teas are, owing to their strength, used by the trade for blending with China teas. Pluckers are paid at a fixed rate per pound of green leaf. With a good flush of leaf on the bushes, a good workman can pick 60 lbs. of leaf in a day. The green leaf, when received into the factory, is handed over to Chinese coolies, who have to turn it into "made tea." First, all the leaves are sprinkled over bamboo trays and placed on stands in the upper floor of the factory under cover. The leaf is handled as little as possible. When the leaves are sufficiently withered, which is known by touch and colour, and the time it takes, depending very much on the state of the weather, they are put into a rolling machine, the box of which holds a charge of fifty pounds. The box is so constructed that when in motion, sliding over a wooden platform, it thoroughly presses, twists, and rolls the leaf without losing the juice. A charge takes about an hour to properly roll, when it is ready for the third stage, which is fermentation. The "roll" or mass of leaf, as withdrawn from the roller, is pressed into a heap upon a low table and turned over repeatedly by hand until the whole mass changes from its previous yellowish green to a bright copper colour, which takes place in about an hour. Then the fermented roll is spread over wire gauze trays and placed in the "sirocco" which is a large iron chest over a furnace. The temperature in this chest is raised to 260° Fahrenheit. There are four trays which slide into the chest at different levels; the topmost tray filled with the roll is put in first and after five minutes is withdrawn, turned over by hand and placed on the second shelf, a newly filled tray taking its place on the top shelf, and so on until the first tray has passed through the four sides, when it has become "made tea," the whole operation taking from 20 to 25 minutes. About 100 lbs. of tea can be manipulated in an hour. Sorting into grades is the next stage. The unassorted teas are fed into a machine consisting of two long cylinders composed of wire mesh of different degrees of fineness. As the cylinders are made to revolve by turning the handle, the tea works down the top horizontal cylinder, dropping out through the meshes according to size, and finally falls into the bottom horizontal cylinder and out at its further end. The finest mesh of course gives the best tea, the lower cylinder being the coarsest. The grades are (1) broken orange pekoe, (2) orange pekoe, (3) broken pekoe, (4) pekoe, (5) pekoe souchong, and (6) souchong. About 40 per cent. of the tea made turns out pekœs, the balance souchongs. The sixth and last stage comprises the following—weighing the different grades upon which weight the factory coolies are paid at a fixed rate per pound; tasting to detect burnt, badly rolled, under, or over-fermented teas; filling into wooden chests lined with lead, and soldering down, each chest holding about 50 lbs. on the average, before which the tea has to be passed through the sirocco quickly once again, in order to expel all moisture before packing, an operation which is known as "final firing," and finally marking the chests with the description of tea, weight, and mark.

The Consul says that the Sultan intends sending specimens of Johore tea to the Chicago Exhibition.

Correspondence.

CREMATION AN INCENTIVE TO CRIME.

It was a matter of surprise to some of the members of your Society, including myself, that Mr. Haden's letter, following his elaborate attack, should have received no notice in your *Journal* from any of the leading advocates of cremation, who, not less strongly than Mr. Haden, desire to see a safe as well as rapid dissolution of the body aftee death. I find, however, that a complete rejoinder from Sir Henry

Thompson was published in December, in the *British Medical Journal*, and I write this with the wish that those who are interested, and have not seen the article, may be aware of the fact.

THOMAS POLE.

Shute-house, Weston-super-Mare.

Obituary.

H. M. BACKLER.—Mr. Henry McLauchlan Backler, who was for many years intimately connected with the gas interest, died on the 30th November, 1892. He was born in Paris on the 12th February, 1824, and received his education at that place. In 1850 he was appointed Secretary to the European Gas Company, and subsequently he became a Director and General Manager of the company. He obtained through Mons. Rouher the privilege by which British companies were placed on the same footing as French joint stock companies. He was also consulted by Mons. Rouher as to the probable operation of the English Limited Liability Law if applied to France when that Minister drew up the measure which now forms part of the commercial law of that country. Mr. Backler was a Director and Chairman of the Oriental Gas Company, and Director of the Imperial Continental Gas Association. He was elected a member of the Society of Arts in 1876.

General Notes.

ARTIFICIAL PRODUCTION OF PRECIOUS STONES. —In the *Journal*, vol. xl., p. 796, there is a short notice of experiments in the production of gems by Mr. James Morris, of Glasgow. The method of production seems to have at least a degree of analogy to the manner of formation in nature, the crystallising agent being carbonic acid. Water charged with carbonic acid is known to be one of the most powerful factors in producing geological changes. Carbonic acid in the gaseous form is also known to play a large part in the phenomena of metamorphism. Direct light on the subject of dispute between the Huttonian and Wernerian schools of geology was thrown by the simple experiment of Sir James Hall, who heated limestone in a closed gun-barrel, and thus prevented escape of the carbonic acid. He found that when the gas was prevented from escaping the limestone became crystalline. The fact that rubies and sapphires are really found in crystalline limestones and dolomites tends at least to show that these experiments have been conducted on natural lines. An article appeared on the subject in the *Chemical News* of August 5th, and in the number of the same periodical for December 23rd Mr. Morris describes the method of production, also the geological bearings of the case, at considerable length.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

JANUARY 25.—WYKE BAYLISS, F.S.A., P.R.S. Brit. Artists, "The Fine Arts in Relation to the Sanitary Condition of our Great Cities." BENJAMIN WARD RICHARDSON, M.D., F.R.S., will preside.

FEBRUARY 1.—WILLIAM KEY, "The Purification of the Air Supply to Public Buildings and Dwellings."

FEBRUARY 8.—PROFESSOR W. NOEL HARTLEY, F.R.S., "On some Points in the Chemical Technology of Oil Boiling, with an account of a New Process for Preparing Drying Oils, for Decorators' and Artists' use." SIR FREDERICK ABEL, K.C.B., F.R.S., will preside.

FEBRUARY 15.—PROF. FRANK CLOWES, D.SC., "The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air."

Papers for subsequent meetings, the dates of which are not yet fixed :—

"Transatlantic Steamships." By PROF. FRANCIS ELGAR, LL.D.

"Tele-photography." By THOMAS R. DALLMEYER.

"The Optical Correction of Photographic Perspective." By H. VAN DER WEYDE.

"Old Age Pensions." By T. MACKAY.

"Music in Elementary Schools." By W. G. MCNAUGHT.

"Technical Education: its Progress and Prospects." By Sir PHILIP MAGNUS.

"Locks and Keys, Ancient and Modern." By HARRY W. CHUBB.

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock :—

FEBRUARY 16.—Sir WILLIAM WILSON HUNTER, K.C.S.I., C.I.E., LL D., "Ten Years of Progress in India." The MARQUIS OF RIPON, K.G., G.C.S.I., C.I.E., will preside.

MARCH 9.—JERVOISE ATHELSTANE BAINES, I.C.S. (Bombay), "Caste and Occupation at the last Census of India." The LORD REAY, G.C.S.I., G.C.I.E., will preside.

APRIL 6.—The Hon. Sir EDWARD N. COVENTRY BRADDON, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisation."

APRIL 27.—Sir JULAND DANVERS, K.C.S.I., "Indian Manufactures." Sir ALEXANDER WILSON, formerly President of the Bengal Chamber of Commerce, will preside.

MAY 11.—Sir RAYMOND WEST, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results."

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock:—

FEBRUARY 28.—

MARCH 21.—CECIL FANE, "Newfoundland."

APRIL 18.—H. A. MCPHERSON, "The Philippine Islands."

MAY 2.—E. DELMAR MORGAN, "Russian Industrial Art."

MAY 18.—W. B. PERCIVAL, Agent-General for New Zealand, "New Zealand."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

JANUARY 24.—HUGH STANNUS, F.R.Inst.B.A., "The Theory of Storiation in Art." W. H. JAMES WEALE will preside.

FEBRUARY 7.—WILTON P. RIX, "Pottery Glazes: their Classification and Decorative Value in Ceramic Design." Sir HENRY DOULTON will preside.

FEBRUARY 21.—T. R. SPENCE, "Wall-papers and Stencilling." LEWIS F. DAY will preside.

MARCH 14.

APRIL 11.—PROF. PAUL SCHULZE, "History and Development of Pattern Designing in Textiles." THOMAS WARDLE will preside.

MAY 9.—W. M. FLINDERS PETRIE, "Primitive Art in Egypt." EDWARD J. POYNTER, R.A., will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

PROF. J. A. FLEMING, M.A., D.Sc., F.R.S., "The Practical Measurement of Alternating Electric Currents." Four Lectures.
January 30; February 6, 13, 20.

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Three Lectures.
March 6, 13, 20.

LEWIS FOREMAN DAY, "Some Masters of Ornament." Four Lectures.
April 10, 17, 24; May 1.

C. HARRISON TOWNSEND, F.R.I.B.A., "The History and Practice of Mosaics." Two Lectures.
May 8, 15.

HOWARD LECTURES.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday Evenings, at Eight o'clock:—

PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

LECTURE III.—JANUARY 27.—Methods of distributing energy—Distribution by shafting—Telodynamic transmission—Installation at Schaffhausen, Bellegarde, and Gokak — Practical defects of the system.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JAN. 23...Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Mr. Duncan Bell, "Aerial Machines." 2. Mr. Wm. Bennett, "The British Navy: Past and Present." (With Lime-light Illustrations.)
Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on papers by (1) Mr. P. D. Tuckett, "A Short Explanation of the Proposed Bi-metallism as affecting British Interests;" (2) Mr. A. Goddard, "The Currency Question and Land."
London Institution, Finsbury-circus, E.C., 7 p.m. Dr. Bridge. "Pepys's Diary and its Musical Notes."
Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, JAN. 24... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. Hugh Stannus, "The Theory of Storiation in Art."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Functions of the Cerebellum and the Elementary Principle of Psycho-Physiology." Lecture II.
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. J. Emerson Dowson's paper, "Gas-power for Electric Lighting."
Photographic, 50, Great Russell-street, W.C., 8 p.m. (Technical Meeting.) Demonstrations by Mr. W. E. Debenham of "Photo-Lithography."
Anthropological, 3, Hanover-square, W., 8½ p.m. Annual Meeting.

WEDNESDAY, JAN. 25...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Wyke Bayliss, "The Fine Arts in Relation to the Sanitary Condition of our Great Cities."
Geological, Burlington-house, W., 8 p.m.
Entomological, 11, Chandos-street, W., 7 p.m.
Patent Agents, 64, Chancery-lane, W.C., 7½ p.m. Discussion on Mr. Ellis's Paper, "Lapsed Patents."

THURSDAY, JAN. 26...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 6 p.m. Prof. Silvanus Thompson, "Electric Lighting." Lecture III.—Accessories and Meters.
Royal Institution, Albemarle-street, W., 3 p.m. Rev. Canon Ainger, "Tennyson." (Lecture II.)
Electrical Engineers, 25, Great George-street, S.W. 8 p.m. Inaugural Address by the President, Mr W. H. Preece.

FRIDAY, JAN. 27 ... SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. Prof. Cawthorne Unwi[n] (Howard Lectures), "The Development an[d] Transmission of Power from Central Stations." (Lecture III.)
United Service Institute, Whitehall-yard, 3 p.m Mr. E. S. Bruce, "Electric Balloon Signalling."
Royal Institution, Albemarle-street, W., 8 p.m Weekly Meeting, 9 p.m. Mr. Francis Galton "The Just-perceptable Difference."
Civil Engineers, 25, Great George-street, S.W., 7½ (Students Meeting.) Mr. Arthur S. Butterworth "The Disposal of Town Refuse by Burning, an[d] the Application of the Heat thereby Generated."
Clinical, 20, Hanover-square, W., 8½ p.m.
Physical, Science Schools, South Kensington, S.W 5 p.m. 1. Prof. S. P. Thompson, "Japanese Magi[c] Mirrors." 2. Mr. W. F. Stanley, "The Perceptio[n] of Colour." 3. Dr. J. H. Gladstone, "Recen[t] Determination of Molecular Refraction and Dispersion."

SATURDAY, JAN. 28...Botanic, Inner Circle, Regent's-par[k] N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m Prof. C. Hubert H. Parry, "Expression and Desig[n] in Music." (Lecture II.)

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FRIDAY, JANUARY 27, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

HOWARD LECTURES.

Prof. W. Cawthorne Unwin, F.R.S., delivered on Friday evening, 20th inst., the second lecture of his course on "The Development and Transmission of Power from Central Motors."

The lectures will be printed in the *Journal* during the summer recess.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by members on application to the Secretary.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d., on application to the Secretary.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was ɩeld on Tuesday, 24th inst. Present: Sir Richard Webster, Q.C., M.P., in the chair; ɩir George Birdwood, K.C.I.E., C.S.I., LL.D., I.D., Sir Edward Birkbeck, Bart., Sir Edward Braddon, K.C.M.G., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael arteighe, R. Brudenell Carter, F.R.C.S., Sir eorge Hayter Chubb, Lord Alfred S. Churchill, rancis Cobb, Professor James Dewar, M.A., .R.S., Sir Henry Doulton, James Dredge, rof. Clement Le Neve Foster, D.Sc., F.R.S., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., C. M. Kennedy, C.B., J. B. Martin, John O'Connor, B.L., W. H. Preece, F.R.S., Prof. W. C. Roberts-Austen, C.B., F.R.S., with Sir Henry Trueman Wood, Secretary to the Royal Commission.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, January 17, 1893; Sir Edward Jenkinson, K.C.B., in the chair.

The paper read was—

MEXICO, PRESENT AND PAST.

By Edward J. Howell, F.S.S., F.I.Inst.

I appreciate the honour that this ancient and honourable Society has done me, in inviting me to address you. The pleasure I experience in doing so is increased by the knowledge that I am speaking to men who are accustomed to look beyond the horizon of daily affairs, and who will, as a consequence, be all the more ready to appreciate the subject of the evening in all its bearings and prospective influences. It is impossible, within the limited time at my disposal, to give more than a glance at that which is so full of deep and lasting interest; for, however careful I may be, there will be much of importance that cannot be included within the scope of the passing moments now at my disposal. I propose, therefore, whilst skimming the surface of many recognised facts concerning Mexico, to occupy your attention with a few of the leading features of interest which have an important bearing upon our future relations with so very attractive a country. For more practical details, and for facts and figures bearing upon many of my statements to-night, reference may be made to my book, "Mexico, its Progress and Commercial Possibilities."

A very little knowledge of Mexico will impress upon you that, both in its present and past, there is no country in the world offering a better field to the intelligent inquirer than this portion of the ancient Spanish empire. With an antiquity equal to that of Egypt and of India, it has been the theatre of mighty events, following each other through the long vistas of the centuries. Although one of the oldest countries in the world, it is yet in its

infancy as regards the development of its resources.

Attractions.

There is an unusual charm about Mexico which stirs up the enthusiasm of the most practical traveller—an almost endless and picturesque variety; making even its very defects and ugliness appear attractive. There is not a human being or passing object that is not in itself a picture, or that would not form a good subject for the pencil. Almost the whole country is a rich museum of antiquities, providing abundant occupation for the explorer, as well as for the archæologist and the ethnologist. Historic records in stone, the witnesses of a civilised past, lie everywhere. Buried cities, pyramids of time-worn stone, broken columns, grim idols whose weight is calculated by tons, half hidden in the prickly pear cactus, gloomy temples like those of Egypt and India, palaces of an architecture as superb as those of Assyria, hidden in virgin forests, which still hold treasures far in excess of those more material and inexhaustible ones which, in all time, have roused the cupidity of the entire world. It is estimated that, during three centuries of Spanish dominion, Mexico contributed treasure to the value of £680,000,000 to its conquerors. The many decades since then have seen the gold and silver streams flow on. According to the "Statesman's Year Book," in the sixty years between 1821 and 1880, silver was produced to the value of £180,000,000, and gold to the value of £968,000; and the present total annual product of metal is valued at £14,000,000. With criminal wastefulness, only the richer veins of every mine and the richer ore of every vein have been worked, the rest being left undug or unreduced, for future generations to glean—if there ever were any need for gleaning amid such a profusion of riches. There are still remaining hidden in the bowels of the earth, glittering in the bed of the stream, or lying in plain sight on the face of the soil, silver and gold, copper and tin, and every rich and precious metal, to say nothing of those other mineral deposits, far exceeding in extent and value those of similar kinds that have enriched whole districts of England and of the United States of America. In a country where gold, silver, and pearls are the ornaments of the poorest, and where the genial climate makes only slight work necessary to provide food in profusion, it is not entirely strange that agriculture seems of little importance. But for this great greed of gold, Mexico might have become the granary of Europe. Innumerable enterprises for developing the country have already produced colossal sums. From lack of ambition, its native inhabitants have hitherto been content to live on as their fathers have done. The lethargy of centuries, however, is now being thrown off, and the people seem to have become infused with a strong desire for upward progress, which, in due time, will make them an important nation.

Geographical Situation.

An examination of the map of the western hemisphere will show you the peculiarly advantageous situation of the country. Washed by the waters of two oceans, in shape that of an upright cornucopia, emblematical of its lasting fulness, the southern portion of the country in its contour forms the head and breast of the pre-historic central American serpent, the Maya symbol of wisdom and power. On the narrow isthmus of southern Mexico and central America are works—at present in progress—which promise to make this end of the peninsula of Mexico a natural centre of that portion of the globe. When either the Nicaraguan and Panama Canals, or the Trans-Continental Railway of Tehuantepec shall have opened it up to the commerce of the world, making a speedy and cheap method of transport across the isthmus, this Egypt of the New World will commence to emerge from its obscurity, and become to us of greater international interest, and, like that other Egypt, have an important influence upon the future of the maritime development of Great Britain; not, however, probably before producing possible complications, an interesting phase of the "Monroe Doctrine" at present existing, by which the United States arrogates to itself the position of having a protectorate over this territory, a doctrine which I am pleased to know is in direct antagonism to the tastes and wishes of the Mexicans themselves.

Area.

The area of Mexico is extensive, containing about 750,000 square miles; about one-fifth of the size of the United States of America, and six times larger than that of the total area of Great Britain. The population is about 12,000,000; three times greater than the Dominion of Canada or of the Argentine Republic.

Water.

The nature of the surface of the land, and the character of the seasons, prevent the formation of navigable watercourses, or the creation of many large bodies of water, although there are numerous streams for water power, and in some districts an abundance of never-failing springs. Under such unequally distributed conditions, water is generally worth more than land, which is often not cultivated because of the lack of the former. The rights and privileges of rivers are, as a consequence, owned and controlled by the State through which they pass. Foreign capital, principally American, is now being interested in the construction of canals, so essential for the proper cultivation of the soil of the country.

Climate.

The climate of the greater part of the country is perfect, and is specially suitable for the habitation of Englishmen and Europeans. Bathed in almost perpetual sunlight, the temperature of each separate locality is almost invariably the same, receiving its different variations according to altitude. The distinctions between summer and winter are so slight, that the seasons are only divided into wet and dry. The series of grand plateaux which constitute the singular formation of the interior of the country, conduce as well to the uniformity as to the diversity of the climate of each district; the different altitudes producing in the aggregate, three clearly defined climatic zones, and giving great variety of temperatures.

The City of Mexico.

A few words respecting the city of Mexico. With a population of 350,000, some say of 500,000, it is the most important city in the country, and is its natural centre, commercially and politically. Razed to the ground in 1521, the city of Montezuma was well and substantially rebuilt by the Spaniards. The streets are wide, clean, and regular, with open spaces tastefully laid out in parks and gardens. No more interesting scene can be presented than the first view of the city from the mountains which surround it; its domes, towers, spires, palaces, and brilliantly painted houses are set in a background of snow-tipped mountains, which stand out against a sky of Italian blueness. In spite of its Oriental colouring and architecture, many of the modern conveniences of civilisation are found there, and it should be noted that electric lighting and tramcar systems are much in advance of ours in England to-day. The one serious exception, however, is its hotel accommodation. Although there are two large buildings specially used for that purpose, the accommodation in them is not such as one would expect in a country where the conditions of living could be made so comfortable.

Its Elevation.—The elevation of the plateau upon which the City of Mexico is built is between 7,000 and 8,000 feet. It has all of the conditions for being one of the healthiest cities in the world, but unfortunately from its peculiar situation, in a sort of basin surrounded by mountains, the soil and subsoil are so saturated with water and the sewage of centuries that it is not to-day a healthy city. A gigantic system of drainage is, however, being vigorously pushed forward by the Government, and which will in due time remedy these conditions. A canal, 47,580 metres, and a tunnel of 10,000 metres in length, are being excavated to carry off the surplus waters and the sewage of the city to control the waters of the valley. The contract for these works is at present under the control of Messrs. S. Pearson and Son, London, who have stipulated to finish it by March, 1894.

President Diaz.

So little is known of the real cause of Mexico's advancement that I am constrained to give you a few facts concerning the remarkable man now at the head of the present Government. To him, more than to any other man, is due the present condition of prosperity and peace which his country is now enjoying. Porfirio Diaz is not only one of the greatest men that Mexico has ever had for a ruler, but when you know his career you will appreciate the difficult task which he has accomplished, and I think you will agree with me, that he is quite worthy to be called the "Bismarck of the Western Hemisphere."

Born in 1830, his childhood was spent in the City of Oaxaca, the chief town of the richest and most interesting State of that name. The ancestors of Porfirio Diaz, on his father's side, were Spaniards, who left their native country in the first years of the conquest. On the mother's side he is descended from one of the most civilised of the original native races. The qualities inherited from both parents are indicated by the remarkable character he has developed in the many

vicissitudes of his eventful life. Deprived of his father at an early age, he received his first training from his mother, a lady of lofty character, and remembered well for her courteous and dignified manner. To her he proved an affectionate and obedient son. Accustomed, even as a boy, to be the leader of his companions in mimic warfare, he early developed the military instincts of his valiant progenitors. When, in 1847, the United States invaded Mexico, he, with several of his college friends, petitioned the Government to be sent to the front. Having valuable ecclesiastical connections, he was intended for the church; but, with the object of relieving his mother from the expense of his education, he, at the age of 19, severed himself from the Catholic seminary, and commenced the study of law at the Institute of Jurisprudence. He here devoted himself for four years to a studious life, and gave lessons for his daily support, showing many proofs of his diligence and skill in acquiring knowledge. In the troublesome times which followed, he was found always upon the side of justice and honour; and, at the age of 25, was called to put into practice what he had learnt of military affairs, for he took the bold step of opposing the dictator Santa Anna, joining a small company of patriots, and, with few arms and poorly disciplined followers, defeated, and finally overthrew a large and well-disciplined body of men of that blood-thirsty and unscrupulous general.

He was afterwards made chief of the police, but, yielding to his military inclinations, renounced what was to him a very lucrative appointment, and, being made captain of a company, succeeded, in 1857, with rare military courage, in putting down an uprising, and, although badly wounded, finally defeating his enemy.

He is next found at Tehuantepec, where he was made military commander of that district. He there successfully maintained the government for two years, under extraordinary difficulties, without receiving aid from the Government, and being compelled to fight almost daily a restless enemy; not, however, without again being severely wounded. Time is too short to tell of his various battles, but he seems to have been almost continuously fighting for the freedom and welfare of his country, until his final election to the Presidency in 1877. Nearly always victorious, his victory over the French at Oaxaca obtained for him 42 pieces of artillery and 2,500 muskets. It should be stated to his honour that his clemency to the defeated procured him great praise from both friends and enemies. His old enemy, General Tamariz, once said of him, "Twice Diaz has conquered me by his military talent and once by his generosity. With pleasure I would serve such a man, although it were as a common soldier." He was specially endowed with the quality of honesty, for in rendering his accounts at the close of his campaign as the victorious leader, he delivered over to the Treasury no less a sum than $140,000, an act which at that time caused great astonishment. First elected to the Presidency in May, 1877, he has remained in power until the present time, with the exception of the period from 1880 to 1884, when General Gonzalez came into power. He was unanimously re-elected last July, and from the present state of feeling in every portion of the country, there is little or no doubt that he will remain in power for the remainder of his life. Diaz's life has been identified with the Mexican Republic for the last forty years, and the whole history of this really wonderful man presents many lessons for the study of future generations. He is to-day, as he has been for many years, the first soldier of the Republic, having fought his way from the time that he was a young lieutenant at the age of 23, to the highest commission in the army, as its Commander-in-Chief. It is not only as a soldier that he has won the admiration and regard of his countrymen, but as a statesman. The true greatness of Porfirio Diaz has been shown in the many political, financial, and diplomatic questions which he has so successfully dealt with. When he first assumed the Presidency the country was bankrupt, and disorder reigned supreme throughout the land. Through his indomitable will and energy, and his administrative ability, this, the most revolutionary country in the world, has been changed to the most pacific. The public treasury, instead of being plundered by those in office, is now devoted only to the service of the nation. The national credit has been re-established, Mexican bonds have risen from about 19 per cent. to about 78 per cent., and the public debt, which was about $150,000,000, has been reduced by about one-third. Mining and agriculture have received a vigorous impulse. Railways are reaching to all parts of the country, and many new lines are now under construction. Many reforms in the constitution and laws of the country have been happily brought about. The President's liberal ideas,

his enthusiasm in the work of the development of the country, and his general honesty of purpose, have enabled him to secure a continuance of public confidence, the people being now profoundly peaceful and contented. The foreign residents live in hearty co-operation with the citizens, who together unite in promoting and defending the wellbeing of the country, seeing, as they do in the continuation in power of such a ruler a harbinger of peace, a guarantee of continued protection, and an encouragement to legitimate and useful enterprise.

President Diaz stands alone to-day, as he has been for years, the most popular man in Mexico. His great ambition is to see his country respected, and occupying among nations that place to which she is entitled by reason of her wonderful resources. These resources are already well known; as to some of the most important I will speak presently.

Although, in some respects, the Government of President Diaz is autocratic, and although he takes a great personal interest in almost every department of his Government, he has very wisely, and with quick political perception, surrounded himself with ministers of strong character and intelligence, and it is the constant aim and effort of his life to place only faithful and honest men in positions of authority.

The popularity of President Diaz was much increased by the influence of his first wife, who devoted much of her time to works of charity. He has been equally fortunate in his second wife, who is also a most excellent and highly educated woman, and who unites with a most admirable presence the sterling qualities of goodness, sweetness, and affability. I am told that Senora Diaz goes about from street to street and from house to house in the poorest districts of the city of Mexico every day, distributing alms and alleviating the sufferings of the poor. From her blameless life, her many charitable acts, and her great tact and amiability, General Diaz no doubt receives a considerable accession to his own popularity.

When the period arrives for General Diaz to consider whether the time has not come for his retirement from the Presidency, then, and then only, will another suitable man for the occasion be found. Such a man of equal rank and position, experienced in European affairs, popular at home and abroad, and devoted to his country, has already been thought of, and in due time the world will see that the destinies of this favoured country are in the hands of men who are experienced and enlightened patriots, and who have the true interests of the country at heart. The work which President Diaz has successfully commenced, has now so commended itself to all classes in the country, that it will not be allowed either to stand still or go back. I have received the strongest assurances from some of the most eminent men in Mexico that this great work of advancing and conserving the prosperity of the nation will be still carried on by others as honest and capable as President Diaz himself.

I have dwelt longer upon this portion of my subject than the time at my disposal would seem to justify, but I have so constantly heard opinions expressed as to the instability of the Government of Mexico, that I have thought the facts I have just given should be known to you, as they have an important bearing upon the future of the country.

Railways.

As railways are the chief factors in the progress of nations, so the means of communication in Mexico, which have been so largely increased during the last few years, are one of the most important causes of the commercial and intellectual progress of that country. Mexico owes the existence of its first important railway to British enterprise; but the Americans have now entirely superseded us in successful railway construction. In the mind of the British investor the name of the "Mexican Railway Company" is cited amongst foreign railway securities as a standard example of the unprofitableness of Englishmen going to Mexico to build railways. The reason for this, however, may be found in the enormous difference in cost of the construction of railways in new countries, between the American and English systems. The English construction of which being estimated at more than three times, and the motive power and rolling stock at nearly double the cost of American lines.

The construction of the "Mexican Railway" was unusually extravagant, even for an English company; but it is considered the most magnificently built railway in the world. Unfortunately, its management having no regard to the conditions of the country, most unwisely arranged freight and passenger rates upon the same high standard as that of the original cost of construction, without doing anything to assist in developing the country

through which the line passed. The natural result of this short-sighted policy was that the railway became of considerably less value to the country than it might have been, and consequently failed to earn profitable dividends for the shareholders. With an excellent opportunity of reaping a golden harvest, the company seems to have entirely failed to profit by it. Had the example of the Canadian Pacific Railway been followed, both in the prudent but equally effective method of construction, as well as in the wise system of developing the territory immediately operated by its line, the results both to English investors, and to Mexico, would have been widely different. It is an axiom that the density of the population of a district or country naturally conduces to the trade of its railway system. To illustrate this, and the possibility of profitably increasing railway facilities in Mexico, I will show by the comparison of the mileage, total area, and proportionate population between Mexico, the Argentine Republic, and the dominion of Canada, that there is abundant opportunity for the profitable building of railways in Mexico.

At present the mileage of Mexican railways is about 6,300, with a total area of 750,000 square miles, which gives a proportion of 14·8 of population to the square mile. The Argentine Republic has 4,840 miles of railway, with an area of 515,700 square miles, and only a population of 7·5 to the square mile. The Dominion of Canada has 14,000 miles of railway to a total area of 3,315,647 square miles (exclusive of the great lakes and rivers), having a population of only 1·45 to the square mile, and yet the net earnings of the Canadian Pacific Railway in 1890 were $6,299,700; in 1891 they were $8,009,659; and in 1892 they will be considerably more. These profits are yet comparatively small to those which may be looked for, when that enterprising company has entirely completed the development of its line. Therefore, with these illustrations it is fair to assume that provided the resources of the country are good and the railway system efficiently administered, that the ultimate success of such enterprises must not be estimated by this one example of the Mexican Railway Company, which British investors are so likely to remember. No one disputes the undoubted mineral resources of Mexico, but although the variety and value of its agricultural resources are to-day but little known to the world, yet if there were no mines in Mexico, the produce of the soil alone, encouraged by a complete railway system, would result in rapidly advancing the general prosperity of the country.

Mining and Minerals.

Upon the mineral resources of the country I fear I shall be tempted to dwell too long, for it is well known that Mexico is literally a money-making country, digging as she does from the bowels of the earth a product, which when put into masses of uniform weight, and stamped with her trade mark, becomes a widely circulating medium of exchange in her own and other countries. In this I refer to silver.

Silver.—The exportation of Mexican dollars to China and the East is a regular commercial operation. The hold which this medium of exchange has obtained in these markets, although exposed to some severe competition with the United States, has never been loosened. Although silver to-day forms almost the entire circulating medium in Mexico, occupying the first place amongst mining exports, it is well to be remembered that in the time of the Montezumas, and afterwards of the Spanish conquerors, gold was regularly mined by the rulers of the country. The most important gold and silver deposits are chiefly found in the zone of about 1,250 miles by 350 miles, comprising the States of Pachuca, Chihuahua, Durago, and Sinaloa, and in the still unexplored mountains of the States of Michoacan and Guerrero, but outside of this district there are also other mines, some of which have been abandoned, and others which are still being prospected. The degree of fineness of some of the ores is of an almost fabulous nature. I have heard of a vein of silver recently discovered by an Indian in Sanora, which assays about £30 per ton. I think I may say in passing that the depreciation in the value of silver has not had any important influence upon the mining industry of Mexico. The mines have, perhaps, continued to prosper because they have been worked more cheaply by substituting steam for mules, and by the more scientific treatment and profitable utilisation of the lower grade of ores. The low value of silver, however, would seem to suggest that the present time is a fitting one for developing the exceedingly rich gold deposits which are said to exist within the territories of Mexico.

Gold.—As an example of gold-mining, the richest district is perhaps at El Ceno Colorado, in the State of Chihuahua. According to the statement of the engineer in charge, the base of the mountain is 1,500 metres long, by 1,000

wide and 500 high. Gold has been found on the mountain top, as well as on the slopes and base, hence it is believed that the mountain contains, approximately, about 400,000,000 cubic metres of ore. The ore is generally in a free state, but at times it is in iron pyrites, and scattered in irregular masses all through the mountain. The limited zone at present worked is found to yield $16 gold to the ton, and comprises about 80,000 tons of ore.

Mercury.—This metal has special interest in the Mexican mining industry, because it is used in the treatment of silver ore in the process generally adopted in the country. There is a yearly consumption of over 700 tons of mercury, of which hardly one-half is produced in Mexico, the rest coming from California and Spain. An English company is mining so successfully in Guadalcazar, in the State of San Luis Potosi, that, with the help of modern machinery, it is expected to turn out a larger quantity than any other mine in Mexico. Mercury deposits are also found at Huitzuco and Concepcion, in the State of Gerrero, and in Queretaro, which, when properly worked, promises rich returns. As soon as the quicksilver mines of Mexico are fully developed, there will be sufficient not only to supply the home demand, but to export to other countries. Time, however, prevents my doing full justice to this and the large variety of mineral deposits of the country.

Iron.—Iron abounds in many States, but, while irregular in quality, is often colossal in quantity. There are many remarkable and very rich deposits. You have no doubt heard of a mountain (called the Cirro del Mercado) of solid iron containing, it is estimated, about 460,000,000 tons. It is an excellent quality magnetic ore, assaying from 70 to 75 per cent. pure iron. This is only one example of the many remarkable and rich deposits which are to be found in the country.

Copper.—These deposits are very numerous, and the mining of it has lately assumed considerable importance. The deposits are rich, some ores yielding from 50 to 65 per cent. of copper.

Tin.—There are also rich tin mines, with deposits which yield from 25 to 75 per cent. of pure metal. A Pittsburg company with a large capital has been established for mining this product, but has not yet commenced work.

Sundry Metals.—There are also deposits of zinc, platinum, lead, and other metals which are being being worked advantageously.

The one thing that Mexico is in most need of is coal. It is found in various parts of the country, but does not seem to have been worked either profitably or satisfactorily. Although used on many of the railways, Mexico is to-day obliged to import large quantities as well from the United States as from our own country.

Mexican Onyx.

There is no marble or other stone which can compare in beauty with the Tecali Mexican marble, or Mexican onyx. It is a Mexican product but little seen in this country, but should offer great attraction to importers. For centuries before the conquest, the Aztec artist and architect found in this marble his favourite material; so highly prized, in fact, was it that it came to be considered as too sacred for common purposes, and was therefore almost entirely used in the erection and decoration of churches and religious houses. In the days of Cortez, altars and baptismal fonts were always made of it when it could be obtained. While the ordinary grades probably surpass in elegance any similar material, it is only in the light and dark grain, the ivory colour, the brilliantly banded, and the dark-red varieties, that a full realisation may be obtained of the great beauty of this stone. Under the touch of a skilled hand, it becomes a gem; it owes its combination of colours to iron and manganese; it is as hard as marble, but susceptible of a higher polish; in the quarries it comes in detatched masses of from a few inches up to 10 or 12 feet. The inferior qualities, that lack colour, are sawn into very thin slabs, so thin as to be almost transparent, which are then coloured and pencilled, to make a fair counterfeit of the real first-class article, after which the side that is painted is covered with a coating of very fine cement, giving it the appearance of having been merely sawn and then polished. All the quarries are small. The most famous, La Padrera, in the district of Tecali, 21 miles from Puebla, is less than three acres, and the average quarry not over seven feet, but the value of the material taken from this small area is difficult to realise. The material obtained is a very fine quality of green, from very light to very dark, sometimes also showing a slight tinge of red or pink.

There are some valuable onyx deposits about 90 miles east of the city of Chihuahua, and in different parts of the country; and, when the stimulus of greater foreign demand shall have arisen, it will undoubtedly become a very favourite decorative marble.

Agricultural Products.

The principal agricultural products are Indian corn, beans, wheat, tobacco, sugar, fibres, and fruit, which I have named in the order of their importance.

The lands of the torrid district near the coast are of wonderful fertility, thanks to the abundant moisture of the soil, kept by the permanent dew and copious rains. Tobacco and sugar-cane, and all the plants and fruits of tropical climates, are produced in this region, and even to the height of 1,500 metres, the banana bears fruit. Perpetual spring reigns on the slopes of the mountains, and in the temperate and colder regions there is found a rich profusion of trees and plants; thus, in great variety, within a very limited area, grow the natural products of most of the countries of the earth. I will glance at a few of the most important.

Tobacco. — From the excellent quality of Mexican tobacco, the value of its exportation has steadily increased, until in 1891 it amounted to $1,107,346. Tobacco growing, under the climatic conditions of the coast lands, requires nothing but capital to make it prosperous. The first cost of the land and the labour is very slight, and the returns upon the capital invested are enormous.

Sugar.—As all the coast lands are favourable for the cultivation of the sugar-cane, so like tobacco, sugar planting requires only capital to make the industry a profitable one. A New Orleans gentleman of great experience in sugar, has stated that for an outlay of £50,000 a net profit of £40,000 per year might be realised.

Coffee.—There is probably no occupation in any part of the world which at the present time can compare to coffee culture in Mexico as a money-making business. The climate seems especially suitable for such culture, and the coffee tree, with little cultivation, becomes one of the surest and most profitable producers. Add to this the fact that Mexican coffee is much preferred to any other in the American market, where there is a ready sale for all that is sent, and that Mexico at present contributes but a small quantity of coffee, in comparison with Brazil, it will be readily seen that the production of this berry in Mexico has unusual advantages. There has hitherto been but little of what is termed the "higher cultivation" of the plant in Mexico, but yet the results have been satisfactory. Coffee plantations, therefore, are to-day more suitable as openings for British enterprise and capital, than perhaps any other industry in Mexico.

Wheat and Corn.—It is estimated that there are about 52,000 square miles of land suitable for wheat and corn. If only one-third of this area were planted, it is estimated that a season's crop would yield about 110,000,000 bushels of wheat, and 440,000,000 bushels of corn; all of which would be available for foreign markets, as the home consumption could always be provided for locally by outlying lands. Mexican wheat is small and hard, and was awarded the first prize in the Philadelphia Exhibition of 1876. Indian corn is widely cultivated in all parts of the country, and at any height above the sea level. It serves for the sustenance as well of the Mexican as for his beast of burden, for the former uses it to make his daily bread, in the form of tortillas. To meet the deficiency of last year's crop, maize has been largely imported free of duty from the United States of America, and, by that means, has saved the people in many districts from extreme suffering.

Textile plants have not been the object of any serious attempts at cultivation, although they are a source of brilliant profit to those who have paid any attention to the industry. They are found everywhere in a wild state, and furnish work for an important per-centage of the Indian population. Henequen is the one plant which is most earnestly cultivated. The Maguey, which is also largely utilised for the national beverage, occupies an important position as a fibre plant; also the Ramie plant, any many others of similar nature, for the growth of which the country seems particularly suitable.

Cotton.—The superiority of Mexican over American cotton is sufficiently proved by the fact that 135 cotton plants from Mexico yield a pound of fibre, while in Texas 200 plants are necessary to produce the same amount, although in Mexico its cultivation is conducted on the most primitive principles. The best cotton in Mexico comes from Acapulco, where the fibre obtains a length of 37 millimetres. From time immemorial, cotton has been the object of important cultivation and manufacture, and was much more extensive under the Aztec monarchy than in our day. The revival of this industry is certain, so soon as the necessary capital and enterprise shall have been introduced.

There are many other products and fruits of every variety, among which are rice, vanilla,

indiarubber, cocoa, sarsaparilla, fancy woods, and dye woods.

The most exquisite fruits grow in great abundance. Oranges, limes, melons, bananas, pineapples, and, in the colder regions, apples, pears, peaches, apricots, grapes, plums, strawberries, and black berries, besides an infinite variety of fruits entirely unknown in this country. An extraordinary fact demonstrates the quality of the Mexican fruit. It always finds a ready sale in California at higher prices than those grown in that State—although California has the reputation of being one of the finest fruit-growing countries in the world.

Cattle Raising.

Where the natural advantages of the country are so abundant, the raising and fattening of cattle on a wholesale scale is naturally productive of large and sure profits. Some English as well as French capitalists have turned their attention to this industry on the Northern Frontier States. The magnitude of the area, and excellent situation of the land suitable for cattle ranches in Mexico, make it a rival in that respect of the Argentine Republic.

Trade.

Although there is at this moment a very general depression in Mexican trade, caused by the failure of the two last maize harvests, and the great depreciation in the price of silver, there is still no great interruption in the material progress of the country. Competition amongst traders has become greater, and perhaps in this department rapid fortune-making amongst them may have received a temporary check. Of the 12,000,000 of its population perhaps not more than 2,500,000 to 3,000,000 are actually in a position to buy foreign productions. The well-to-do and richer people require all the refinements of modern life, but the middle-class buy articles of poor quality, which are generally of German manufacture. Mexican traders are very courteous in their manners and strict in their conduct, but require in their treatment a certain tact, much patience and urbanity. They require long credit and are slow to pay, but as a class they are distinguished for their honourable dealings. Failures are very rare, and there is amongst them, I am glad to say, at present a strong reaction against the long-credit system. If the English manufacturers want the trade of Mexico they must go and fetch it, for the most desirable and conservative Mexican merchants stay at home and do not attempt to seek new connections abroad. In dealing with such men, you have to treat them as you would like to be treated, and with the same consideration you would demand from others. You will then make a good customer of him, and of his neighbour also.

During the year 1891, there were 58 foreign companies formed for undertaking business in Mexico; of these, 20 were English, representing a capital of £3,788,200, the others were American, and represent a capital of £14,107,000; but many of these companies have not yet commenced operations, and perhaps never will. Apart from these, however, private individuals (especially American citizens) have spent large sums of money in the country in the purchase of lands and mines, and in the construction of industrial establishments.

Financial Conditions.

The financial reports concerning Mexico have been for some time equally depressing with those of other countries. This depression of business must only be understood as comparative, the minimum of trade to-day being, in fact, far in excess of what it was ten years ago. There is, at present, a large amount of capital locked up, which only requires a complete restoration of public confidence to release, when it will again enter into new activity for the benefit of the country.

Mexico has a total national debt of £22,000,000, which is gradually paying itself off by a sinking fund. This sum is a bagatelle in comparison with the country's great resources. The interest of the debt has been punctually met, and the two last years' statements of revenue and expenditure were extremely satisfactory, the revenue being in excess of expenditure. Thus, when all the world is feeling the pinch of bad trade, the financial conditions of Mexico may be considered as perfectly satisfactory.

Improvements and Suggestions.

There is much more needed in Mexico than the importation of foreign capital and enterprise. The shrewd investor would have to adopt all the improvements in agricultural implements and labour-saving machinery. The difficulties of local transportation is also a want which has to be considered. The low prices of the most fertile lands are of little value, if they are distant from railways, and from the great centres of population. Culti-

vation of land, on a small scale, however insignificant its cost, would not be profitable unless in, or near, the great centres of population. It therefore becomes evident that only extensive properties under well-organised conditions can be profitably worked; these wil receive every consideration at the hands of the Government, who will be found always ready to negotiate and arrange special conditions favourable to any intending purchasers. One of Mexico's greatest drawbacks is her system of taxation and methods of collection. Trading with Mexico is, at present, seriously handicapped by the high tariff and by the vexatious difficulties attending the shipment of goods into the country. The present system of imposing fines for the most trifling deviation from the prescribed form, and the pernicious custom of giving half the fine to the poorly-paid official inflicting it, offers a premium to dishonesty. Shippers of goods to Mexico, however careful, and however willing the officials at the Mexican Consulate may be to assist them in the proper filling up of documents, &c., are unable to avoid, in a large number of instances, the consignee being fined $100 and upwards for some supposed infraction of Customs' regulations. I commend this subject to the various Chambers of Commerce, and other commercial organisations, that proper representation may be made to the authorities to amend an evil which, at present, is a most serious drawback to the reciprocal trade relations of the two countries. I may also mention another matter. There is a disposition on the part of the rich men in the country to hoard money, and I am told that in the city of Mexico alone, there is fully $15,000,000 in silver laid away, earning nothing. It is necessary that this spirit of distrust should be removed. Special English organisations are needed for promoting new undertakings, with the object of encouraging the people themselves to unite in such efforts for the development of their country. It is remarkable that not even a stock exchange exists in the city of Mexico. Such an institution, to give market quotations for mining and other shares, would not only aid the Mexicans, in providing them with facilities for proper investment (instead of the now useless hoarding of their savings), but would also greatly stimulate the many enterprises directly interested in the development of the country.

Another advantageous opening would be for a company to undertake the construction of tenement houses and decent dwelling places in the outskirts of the cities, suitable for artisans and clerks with small salaries. Well ventilated houses, with flats and apartments, provided with all modern sanitary appliances, would give a handsome return upon the cost of their erection. This great want, and that of a a first-class hotel in the City of Mexico, are the two great needs which the ordinary visitor to Mexico most quickly recognises.

Immigration.

As it is quite possible that, in the near future, the subject of immigration to Mexico will become a prominent one, I desire to say, for future guidance, that, although there are few countries to-day which present to the suitable immigrant greater advantages, yet I must not be understood to advocate emigration to that country except under carefully guarded conditions. It must always be remembered that people who have no money, but only strong arms and good habits, should not go to Mexico, for they will find here, as rivals, several millions of Indian workers, who have also good habits, and arms strong enough, and who are content to work for wages which would be impossible for Europeans to live upon, thus rendering competition with them out of the question. I must state, however, that there are excellent opportunities, in many parts of the country, for good machinists, boiler makers, and skilled mechanics; but these should be specially warned against attempting to obtain employment in the city of Mexico, where the labour market is over-stocked in almost every department of trade.

Origin.

I cannot close this paper without referring to the most interesting of all subjects, that of Mexico's early civilisation, as demonstrated by her ruined cities and the palaces and monuments of the Mayas, which are found hidden in the midst of the impenetrable forests of Yucatan and Southern Mexico. I do not presume to speak of these as a discoverer, nor have I had the good fortune of even exploring these hitherto supposed mythical cities. Travellers in Mexico are told of populous towns, far from the haunts of travel; but no white man who has ever attempted a visit has ever returned alive to tell the tale of them. The fierce inhabitants of those regions are of gigantic stature; have rites, customs, and wondrous

secrets of their own, of which others know nothing. They have a knowledge of herbs and of poisons, with their use and antidotes, unknown to science; and they are supposed to have a knowledge of hidden treasures and of precious stones and metals, but which they can never be induced to reveal.

It was my good fortune to have made the acquaintance, seven years ago, of the eminent explorer, Dr. Le Plongeon, who knows more than any living man concerning these regions, and who has devoted eleven years of research to the subject of the origin of the ruined cities of Mexico. By living, for many months at a time, in close proximity to them, he has succeeded in establishing a very possible theory concerning them, and has brought away with him a large amount of archæological material, including fictile impressions of sculptures and inscriptions, &c. To much personal intercourse, and a continued correspondence with this gentleman, I owe a large amount of the interest I have taken in the subject, and which has since been greatly increased by opportunities I have had of seeing those silent records in stone in museums and other places in Mexico.

With your permission, I will relate a few of the facts Dr. Le Plongeon has given me concerning them. His latest letters inform me of certain discoveries of great historic importance, relating to the remote period of the construction of these cities, palaces, and temples. By the revelations made, by translations of inscriptions, and other records found there, Dr. Le Plongeon tells us to look to the West for the earliest traces of civilisation; for as the Western Continent is geologically the oldest, so, he says, it is also the cradle of the earliest human civilisation, and the birthplace of our primitive traditions. Dr. Le Plongeon states that he found the key to these translations by observing one day that certain characters and signs of the inscriptions carved on the old walls of the buried cities in Yucatan were like Egyptian characters. This led him to think that others might also have the same resemblance. By following this clue, and by giving them the same phonetic value in the Maya language, he found others which all resulted in intelligible words and sense. In making this comparison of the two kindred languages, which he has already treated in detail, in his published book "Sacred Mysteries among the Mayas," Dr. Le Plongeon has been careful to state that he makes use of the Egyptian alphabet as given in a work by Mr. Champollion le jeune, also of the alphabet published in the "Encyclopædia Britannica," as well as that one forming part of the ancient alphabet, page 1769 of Noah Webster's English Dictionary, and of another published by Christian Bunsen. Having thus been so fortunate as to find a means of deciphering these hitherto mysterious and unknown hieroglyphics, which for so many ages have baffled the attempts of the curious, he next turned his attention to the Troano MS.; one of the four known books which escaped destruction at the hands of Bishop Landa, and other fanatical monks who accompanied the Spanish conquerors in their first invasion of Yucatan. By this method of translation he finds this MS. to be a treatise on geology, containing as well something of mythology and history. It tells also that originally the peninsula of Yucatan was called Mayax, which thus gives its name to the whole Maya empire, the word "Mayax" meaning, as he says, "The first land." "The primitive land" is met with in many countries, in Asia, Africa, and Europe, as well as in America. This interesting MS. records that Uxmal was the seat of Government, and Chichen Itza that of the arts and sciences To this centre of learning came wise men from afar; bearded men, like the Assyrians of old and the Afghans of to-day, to consult the learned priests, the walls of whose college are still remaining at Chichen Itza.

One chapter of the Troano MS. is of extraordinary interest, as it gives an account of the submersion of a great island called "Mu" in the Atlantic Ocean—the same island known as "Atlantis." Dr. Le Plongeon has found three different narratives of this cataclysm, in Maya hieroglyphics, by three different authors. The following is his translation of the paragraph in the Troano MS., describing the last scene of that terrible event, which is as follows:—

"In the year 6 Kan, on the 11th Muluc, in the month Zac, there occurred terrible earthquakes, which continued without interruption until the 13th Chuen. The country of the hills of mud, the land of Mu, was sacrificed; being twice up-heaved, it suddenly disappeared during the night, the basin being continually shaken by volcanic forces. Being confined, these caused the land to sink and rise several times and in various places. At last the surface gave way and ten countries were torn asunder and scattered. Unable to withstand the force of the seismic convulsions, they sank with their 64,000,000 of inhabitants, 8,060 years before the writing of this book."

Dr. Le Plongeon states, that the Maya tongue has a great number of roots and words identical with the old Greek language, and that many Maya words and characters have precisely the same meaning and value, in both the Maya and Egyptian languages. Therefore, as the Egyptians always point towards the setting sun as the birthplace of their ancestors, so the Chaldee gods were named with Maya words, descriptive of their attributes. As the Chaldee magicians used Maya words in their exorcisms, and as the words written on the banqueting-hall of Belshazzar were Maya words, having the same meaning as those given in the Book of Daniel, so there is a strong presumption that the nations of the East and West have the same origin.

Dr. Le Plongeon also informs me that the sculptures which adorn the east façade of the palace of Chichen Itza, describe the creation of the world ; but, as I have already trespassed too much upon your time, I will conclude by stating that Dr. Le Plongeon assures me that he has a positive knowledge, from the interpretation of certain mural inscriptions, that there are still buried and hidden, in certain monuments in the two cities of Chichen and Uzmal, whole libraries of the ancient Maya philosophers. These were no doubt hidden, to save them from the Nehault invaders of the country in the 5th century of our era.

Dr. Le Plongeon summarises the chief points concerning the Maya early civilisation thus :—(1) That the Mayas had an alphabet, and wrote the history of their people on stone, papyrus, and parchment ; (2) that they carried their arts, sciences, religion, language, and traditions all over the world—that they were travellers, navigators, merchants, colonisers, and civilisers ; (3) that intimate communications were kept up in very remote ages between the Mayas and other nations in various parts of the earth, as the Maya language, with the same signification, is found in India, Chaldea, Greece, and Egypt ; (4) that, in the ancient Egyptian civilisation, the same manner of writing and of archiving their history on the walls of their temples and palaces was the same as amongst the Mayas, and that even the names of the city and country itself are words belonging to the Maya language, descriptive of the locality or other characteristics ; (5) that the mooted question of the existence and destruction of a large and thickly-populated country in the midst of the Atlantic Ocean, is solved by the many different Maya inscriptions and writings he has discovered recording it. These are some of the chief points he has given me.

I regret that I am so poor an interpreter of Dr. Le Plongeon's discoveries, but if I have failed to impress my hearers, I trust I may, at any rate, have done something towards bringing this most interesting subject of ancient American civilisation to the attention of learned and scientific men, who are more able than I to investigate it.

DISCUSSION.

The CHAIRMAN said the interest he took in Mexico, and the knowledge he had of it, tempted him to make some lengthy remarks upon the very suggestive paper which had been read ; but, as he wished to give time to others, who might probably know more about the subject than himself, he would make his remarks as brief as possible. He could not quite go with Mr. Howell, when he said that Mexico was one of the oldest countries in the world, and that the stones, which could be seen everywhere about, bore testimony to an ancient civilisation, because, as a matter of fact, it was admitted now, that previous to the time when Columbus disoovered America, there was no nationality in Mexico, and there was no civilisation such as we in these times accepted as the definition of the word civilisation. Regarding the administration, the material progress, and agricultural products of Mexico, he wished to say a few words. He fully endorsed what had been said regarding that great statesman, General Porfirio Diaz, President of Mexico, having the honour of his acquaintance ; and last March, when in Mexico, he had a long and interesting conversation with him. To President Diaz, Mexico owed all the material progress that had been made during the last 12 years. Long might he live to retain the position he now held, both in the interests of the people of Mexico, and in the interests of the commerce of the world. General Diaz was a most enlightened and thoroughly honest administrator, in addition to being a very distinguished soldier. To show that General Diaz's wish was that honesty should prevail in Mexico and that corruption should cease, he might mention a conversation which he had with him in 1889. He was speaking about the evil practice which prevailed to a certain extent of offering money and other presents to Government officials by foreigners who were engaged in commercial enterprise in that country. He (the Chairman) asked whether a stop could not be put to this, to which General Diaz replied, what was he to do if Englishmen and Americans would come into the country, and whenever they wanted to promote a commercial enterprise offered bribes to officials. He went on to say: "If you will stop that practice, I will undertake that it will be soon stopped in Mexico." When he said this, he merely spoke what

was the actual truth. The Europeans who went over there to promote enterprises were much to blame for the practice which at home was so much condemned. As to railways, Mr. Howell had pointed out the extreme importance of them, and every one well knew that the development of a country depended upon the extension of railways. He did not think it was quite fair to put the railways in Mexico on the same footing as those in Canada and the Argentine Republic, as the conditions were in many respects different. In the first place, difficulties in trade arose from the evil tariff, which he hoped would be improved before many years were past. Secondly, in the case of Canada and the Argentine Republic, they were dealing with young progressive countries with a constant flow of European immigration, and in the tilling of the lands and the working of the mines they had that which was most essential, viz., European energy and labour. This was entirely wanting in Mexico. The railways were made in an old country where a great deal of the land was owned by persons who had held it for a long time, who had hardly any money of their own, and who would do nothing to develop the country. Another reason for the railways not succeeding so well in Mexico as in other countries was, that they had been made in long trunks through a desolate country, and feeders had not been made to connect the towns and places where produce was grown, with those trunks. Those were conditions which were peculiar to Mexico, and which accounted in a great measure for the poor returns which the railways had hitherto given. There was one other reason also, and that was the great initial expense of constructing the railways. Mr. Howell rightly said that the railways had been constructed too extravagantly in that country, but there was also another reason, that those who had been representing European capitalists had fallen into the bad practice of paying very large sums to the people who had helped them in the promotion of the enterprise, and to those from whom they bought the concessions. Those things had very much handicapped the railways, and raised the amount of the capital, thereby lowering the dividends to the shareholders. With regard to the agricultural products of the country, he thought he need not say much. Coffee was really a very important and profitable industry. Last year he went from San Francisco all down the Pacific, touching at every port in Mexico, and in Guatemela he found that the coffee cultivation had reached very large proportions. This industry had extended to Chiafas, the State in Mexico bordering on Guatemala. Prices being good last year, people, after paying for the cost of cultivation, freight, and commission, made $15 gold net profit upon every 100 lbs. of Spanish coffee. That would show what could be done in a good year. A smaller profit than that would give a very good return to the investor. Another product which was exceedingly profitable was the cacao from which chocolate was made, the product of each cacao tree fetching about $30. There was a very large demand in Mexico for cacao, which was very largely consumed, and there was not sufficient to meet the demand. Another thing in which it would pay well to invest was the cultivation of india-rubber trees, though money would have to be locked up in that industry for over six or seven years, as the trees would take about that time to grow. The cultivation of mulberry trees and of silkworms would also be a profitable investment, as raw silk might be produced which could be sold to great advantage in America, where, under the McKinley tariff, it was admitted free of duty, in order to encourage the manufacture of silk goods in the United States. He had no doubt whatever in his mind that if people would only exercise caution and look before they leaped, they would find that Mexico was a country in which money could be invested with great profit. It was a pity that a great want of confidence had been introduced owing to people having unwisely gone into schemes without inquiring fully into them, and had, therefore, constantly lost their money. Then we had had the great financial crisis of 1891, and the Baring collapse, which had also increased the want of confidence, and induced people to lock up their money, and not to invest in anything unless they considered it to be as safe as Consols. No doubt in time confidence would be restored. If people would only inquire into the nature of the thing in which they were going to invest, and see whether the title was good, and make an estimate of what the cost would be and the return, they would find a good and profitable investment for their money. He should like now to say a few words upon what to every one must be of supreme interest, viz., the origin of the population of America, which up to now had been a subject on which little was known. It was not at all improbable, as Mr. Howell had stated, that the people of the East and of the West had a common origin, but recent researches proved beyond a doubt that the inhabitants of America, for thousands of years before Columbus discovered it, had had no connection whatever with any part of the outside world—Asia or anywhere else. People from time to time had started different theories, and had endeavoured to establish a resemblance between the myths, the languages, and social customs of the people of the East and West, but it was now generally admitted, by those who had gone into the subject, and by geologists, that the people of America had no connection with the people of the East at all. It was now generally believed that, in the glacial period, 250,000 years ago, the inhabitants of America came across from Europe on the ridge of land which it was known extended from Europe to America, *viâ* the Orkney Islands, Iceland, and Greenland. No doubt this ridge had been submerged by some convulsion of nature. Reasoning from that, they came to the conclusion that the whole people of America, excepting the

Esquimaux, were one race. The more inquiries were made, the more they were led to the conclusion that the people of America were, so to speak, indigenous; and then there was no evidence to show that they had any intercourse with the East for the 20,000 years preceding the discovery of America by Columbus. The great lesson which was born in upon us, from an admission of that fact, was this, that, although different races of men might be separated from each other from time immemorial, yet, under similar circumstances, society went on progressing in similar ways; and one comes upon societies, as the Spaniards and Columbus did, developing almost on the same lines as the Greeks and others had developed in different parts of the world. Among the Greeks, before a man came to be king, he was the "leader of men"—elected as the head of the tribe, and also the priest. When Cortez arrived in Mexico to conquer that country, he found Montezuma with exactly the same language—he was called the "chief of men." There were strong reasons for supposing that the Mayas and the Mexicans were of the same stock; but the Mayas were, in some points, far superior to the Mexicans. They were not civilised, but they were further advanced on the road to civilisation, and they had hieroglyphics, which they used to write on Maguey paper or deerskin parchment. But both Mayas and Mexicans were barbarians; they were cannibals, and went in for human sacrifices. It was clear that they did not know the use of iron, in fact, they did not use iron at all. The old ruined cities had been for years the subject of controversy; it had been supposed that they were so ancient that it was impossible to fix the date when they were built; but recent inquiries had shown that they were not nearly so ancient as had been supposed. The oldest cities, probably, did not date back earlier than the 12th or 13th century, and some of them were not older than the city of Mexico, which was founded in 1325 A.D. Talking of these cities, he might mention one very curious thing bearing on the controversy which had raged about them. In Palenque, in the State of Chiapas, was found a cross like the Iona cross, the two bars nearly equal, and surrounded by a circle; various theories were set up about this cross. Some said that Norsemen had sailed down the coast, had established a Christian colony, and had set upon their temple the cross, the smybol of their religion. This idea was not founded on fact. The explanation was an exceedingly curious one. When Cortez landed on the coast of the Gulf of Mexico, he attacked the towns near the coast, and in one town he stormed the temple and pulled down all the idols, and set up the Christian cross upon the temple, when the people at once said, "Now we know that this is our god." They submitted to him because they said, "He is putting up the sign of our god." It was a curious coincidence that the cross, which was the emblem of Christianity, was also the emblem of Quetzalcoatl, the god of the Aztecs. The cool Mexican table-land was probably first populated by tribes of Nahuas, which came down from the north in the 6th and 7th centuries. Later on, about the 11th century, some further tribes came down from the north, all belonging to the same people. Among these were the Aztecs. These men, finding that all the best positions were occupied, fixed upon a marshy place, on the borders of Lake Tezuco, on which they founded, in 1325 A.D., the city of Mexico. Later on, this tribe, uniting with two other tribes on the same lake, "formed the Triple alliance of the lake," which succumbed to the valour of Cortez and his Spanish soldiers. It was a remarkable thing to see what a mark the Spanish people had left on Mexico. From one end to another the Roman Catholic religion prevailed; in every town Roman Catholic churches would be found, and Spanish was the only language spoken.

Mr. FURBER said after the exhaustive way in which the subject had been dealt with by Mr. Howell and the Chairman, he could add but little to the discussion. He had been personally interested in Mexico for many years, and had watched its astonishing progress under the able administration of the present President. He could only say with the Chairman that it was his impression, founded on some experience, that any gentleman who would go into well-considered enterprise in Mexico would find an ample return for his money. He was very much amused some time ago, in discussing Mexico and its present position with people who were desirous of going into enterprises in that country, at the amount of ignorance which existed on the subject. People seemed to think that Mexico was a barbarous country, but this was not so. An Englishman conducting himself well could go through the country from end to end without the least danger. There was no more necessity to carry a weapon in Mexico than there was in London. He quite agreed with the remarks of the Chairman as to feeing officials in Mexico, but he thought it was very much the same as feeing servants at hotels—if you did not do it you would not get attended to.

Mr. BEST asked whether it was possible to obtain a good map of Mexico?

The CHAIRMAN said an excellent map could be obtained at Stanford's. Separate maps of each State, with full statistics of population, land, and other things, could also be obtained in Mexico and New York. Copies of these maps were in his possession, and he should be glad to show them to Mr. Best. Very ample information upon Mexico could also be obtained in Mr. Howell's book.

Mr. BEST asked whether the Consul's report had been published yet?

The CHAIRMAN replied in the negative. He then proposed a most hearty vote of thanks to Mr. Howell for his interesting address.

Mr. BOEHMER seconded the motion, which was carried unanimously.

Dr. SWITHINBANK said the Chairman's address had thrown a great deal of light upon the subject of Mexico. He knew something of Mexico and its prospects; and his own opinion was that there was a great future before that country.

Mr. HOWELL said he thought the Chairman had dealt tenderly with him, considering that he (Mr. Howell) had made some very strong assertions. He had not had time to do more than give a very feeble idea of what Dr. Le Plongeon had given him. He had received a very voluminous correspondence from that gentleman, from which he had culled the few facts which he had placed before his audience. For every fact which he had given, there were many that he had not had time to refer to. He might mention that the Chairman had taken Prescott's view of the origin of the early civilisation of Mexico. He (Mr. Howell) had gone far beyond that. When Cortez arrived in the country, he found many of those ancient monuments in nearly the same state as they were to-day. The Aztecs who made such a gallant fight against Cortez were certainly not the people who built the palaces and temples of Yucatan. This sanguinary people were undoubtedly cruel, with rude and barbarous customs, but the Toltecs who preceded them had a greater degree of civilisation, and were a highly moral people, with a religion as mild as their disposition. The prayers of the Toltecs were very beautiful, and their offerings were of fruits, flowers, and birds. Both of these were tribal branches of that great Nahualt people of whom the Chairman has spoken. Tradition says that these came from the north, but it seems quite possible that the Mayas, whose buildings we have seen to-night on the screen, might have had altogether a prior history and different origin to the Nahualts. Those who wish to know many instructive facts which seem to give a clue to the origin of these people, would do well to read a book entitled "Atlantis," by Ignatius Donnelly. Anyone who reads that book will perhaps discover a basis on which to put Dr. Le Plongeon's latest and remarkable discoveries.

The CHAIRMAN said that in putting forward the views which he had done he had no intention of being dogmatic. When one was dealing with things which happened thousands of years ago, it was very unlikely that they could be all quite right—there must be a deal of supposition and theory. He had not drawn in the slightest degree from Prescott, as he looked upon that as ancient history.

INDIAN SECTION.

Thursday, January 19, 1893; SIR THEODORE CRACRAFT HOPE, K.C.I.E., C.I.E., in the chair. The paper read was—"The Currency Problem," by J. BARR ROBERTSON.

The Discussion was adjourned to Thursday afternoon, 26th inst.

The paper and reports of the discussions on January 19th and 26th will be printed in the next number of the *Journal.*

APPLIED ART SECTION.

Tuesday, January 24, 1893; W. H. JAMES WEALE in the chair. The paper read was—"The Theory of Storiation in Art," by HUGH STANNUS, F.R.I.B.A.

The paper and discussion will be printed in the *Journal* shortly.

SEVENTH ORDINARY MEETING.

Wednesday, January 25, 1893; BENJAMIN WARD RICHARDSON, M.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Brown, Nicol, Sunnymeade, Muswell-hill, N.
Cowan, William James, 17, Coleman-street, E.C.
Dowden, Colonel Thomas F., R.E., care of Cox and Co., 16, Charing-cross, S.W.
Jenkin, Barnard Maxwell, 29, Whitehall-court, S.W.
King, William Henry, 34, Park-road, Haverstock-Hill, N.W.
Kipping, Percival Philip, Oxford-court, Cannon-street, E.C.
Osenton, George, jun., Westerham, Kent, and Horley, Surrey.
Spencer, Augustus, School of Art, Leicester.
Thomas, O. V., Government-house, Singapore.
Waylett, Richard Morris, 534, Oxford-street, W.

The following candidates were balloted for and duly elected members of the Society:—

Anderson, Tom Scott, 59, Wilkinson-street, Sheffield.
Ferrar, William Grey, Broad-street House, E.C., and Redclyffe, Ilford, Essex.
Giddy, Osman F., 121, Pall-mall, S.W., and Cambernauld, Feltham-hill.
Heap, Ray Douglas Theodore, 35, Addison-gardens, Kensington, W.
Statham, William, The Redings, Totteridge, N.

The paper read was—

THE FINE ARTS IN RELATION TO THE SANITARY CONDITION OF OUR GREAT CITIES.

By Wyke Bayliss, F.S.A., P.R.B.A.

In addressing you on the subject of the "Fine Arts in Relation to the Sanitary Condition of our Great Cities," I am met by two difficulties—a Scylla and Charybdis—that might appal one who had not set out with a determined purpose, or was not sure of his way. The first difficulty is, that the work of the artist and of the sanitary engineer seem to stand so very far apart in our minds, that I may be challenged with the question, "What have they to do with each other? Speak about either of the two things, and we will listen; but let us have one thing at a time." The second difficulty is, that the two—Art and Sanitation—are so nearly identical, are so interwoven in their action and re-action, that you may too hastily assume that anything I may have to say regarding their relation to each other must necessarily be obvious and trite.

Now I am not afraid of either of these difficulties. In simply stating them I have left both behind, and am content to let Scylla take care of Charybdis. For, when you come to look into the matter, what is Art, but the science of beauty; and what is Sanitation, but the science of health; and are not beauty and health pretty nearly synonyms? At any rate, the two things go very much together. They "keep company," as the lads and lassies say. Where perfect health is, there is beauty. Where perfect beauty is, there is health. In other words, if health is the foundation of the temple of beauty, beauty is the shrine in the temple of health.

Now, I know that I am speaking to citizens of no mean city. I am ready to admit, if you tell me that it is so, that all our great cities are lovely and healthy, and that London is the loveliest and healthiest of them all. But whether this be so or not, one thing is certain, viz., that to us it is our home. And when our short English summer is over, and the dark days of winter are upon us, it is a matter of no small moment to us what our home is like. From sunny fields and silvery streams, from sea and lake and forest, from the golden light of the south, and the eternal snows of mountain fastnesses, we stream back to London; and we know not whether, when we get up in the morning, we shall be able so much as to see each other's faces across the street. Is London, in the month of January, a desirable place in which to set up a studio for painting? Is London all that could be desired as an Art centre? Is it not worth while to inquire whether we could make our great cities more habitable—more pleasant to live in. That is the question to which I address myself to-night.

And I will begin by laying before you a series of propositions, to which I invite your assent.

The first is, that the progress of Art in our country, and the free development of some of its finest characteristics, have been arrested by the foul condition of the atmosphere of our great cities.

The second proposition is, that the appliances necessary for the sanitation of our dwellings are not irreconcilable with the laws of beauty.

The third is, that, according to the law of beauty, as well as the law of sanitation, things are right only in their right place.

The fourth is, that if you can do nothing better with works of art than smoke them black, like flitches of bacon, your artists will probably (according to the law of supply and demand) give you works suitable for that purpose.

My fifth proposition is, that any great scheme for the future of National and Historic Art in England is hopeless so long as this state of things continues.

And finally, I shall put it to you, that to find a remedy for these evils, Societies of Artists have to look to the Society of Arts.

Upon each of these propositions I will say a few words, though, having regard to the limited time at my disposal, they must be very brief.

And first. Do we sufficiently realise how *the advance of Art is hindered by the insanitary condition of our great cities?* Take, for instance, Architecture, and see how dirt stops the way. How it stops the way, not only of the traffic in our streets—an army of scavengers may cope with that—but how it stops the way of all the splendid developments of decoration, by virtue of which Architecture takes rank amongst the Fine Arts.

Just think, for example, what the *facade* of a public building might be, but for this all pervading, ever-increasing plague of atmospheric dirt. We need not go back in imagination to the time when our forefathers saw the splendour of Westminster Abbey; its delicate tracery, its shafts of marble, its wealth of statuary—long since lost to us in the veil of black

slime that covers everything in London. We need not, I say, go back to the past. We have only to seek out some cathedral in purer air, that has not yet been defiled, to see that the defilement comes, not of age, but of dirt. Lincoln, for instance, or Winchester, or Ely, or Salisbury, still show us what magic can be wrought in stone by the wizards we call architects. Why is the loveliness of the natural colour of stone to be seen only by a handful of villagers, or the inhabitants of a small provincial town—why not by the toiling millions of the metropolis? The buildings are there. Beneath their shadow runs the perpetual stream of human life, St. Paul's in the east, Westminster Abbey in the west, each with its own splendour, and the stream of life for ever ebbing and flowing, like the great river that runs between them. But the river is thick with mud, so that the people cannot drink of it; and St. Peter, at Westminster, and St. Paul, in the city, looking out over the surging masses, cannot see each other, for the air is black with smoke; and the people pass and re-pass, and know not that the grimy objects that fill the niches of the Abbey are amongst the loveliest of the sculptures that the world has ever seen.

But that is only one aspect of the case; it shows how much we lose of the work already accomplished by the great architects of the past. But just consider what we lose in the limitation it places on our efforts to create new forms of beauty. Westminster Abbey is built of stone, and depends for its loveliness on the grace of its structure and the splendour of its sculpture. But Art has other resources at her command, and notably amongst these is colour. The *facade* of Siena Cathedral, or the Duomo of Orvietto, or St. Mark's, Venice, are also full of carving; but amidst the carvings are mosaics; the walls are of marble and porphyry, rich with every change of colour—russet and grey, purple and gold; shafts of malachite; panels of *lapis lazuli*. Why do we in England see nothing of all this? In Orvietto, every public building—I might almost say, every house—is as finely engraved, in proportion to its size, as a signet ring; as delicately coloured, by the use of brick, or stone, or marble, or terra-cotta, as an inlaid cabinet. And then the great west front of the cathedral. The city stands upon a hill, from which you can see, for fifty miles round you, the fair Italian landscape and the beautiful blue line of the Apennines. The sun goes down, and you feel that Nature can yield no greater splendour to your eyes than that fair landscape, with the golden light deepening into crimson in the west. But then you turn round and look at the mighty Duomo, flushed with the crimson and gold of the sunset, and you learn what Art can do—not to surpass Nature, not to compete with her, but to interpret her, to reflect her, to make you understand her better. The great windows flash like jewels, the arches are filled with mosaics of the Apocalyptic vision; every stone is engraved with some story of the saints, or of the Passion of Christ. And perhaps, as darkness falls upon the city, and you walk back to your hotel, you begin to think—what resources of the chisel of the engraver, and the saw and wheel of the lapidary, and the smelting pot of the worker in mosaic, are lost to our architects, simply because of the foulness of our atmosphere—a foulness not inherent to it, but made by ourselves in the innocent process of cooking our mutton chops.

For observe—the fault is not to be charged to our climate. Orvietto, indeed, is on a hill, where the air is always pure, but Genoa, and Pisa, and Venice, and Naples are in reach of the wet, salt, mists of the sea, and yet they are beautiful. Ah, no, it is not the climate that we have to fight against. It is the climate plus dirt. It is the climate in unholy alliance with the guerilla contingents of smoke and foul gases, that decimate our forces, and carry foolishness into the councils of our building committees. Are you going to help us against this enemy? Are you going to clarify the air of London, and Liverpool, and Manchester, and the other dark places of the earth? If it be true that "the dark places of the earth are full of the habitations of cruelty," it is equally true that they are full of the habitations of ugliness. Are you going to give the artist that which he values as his life—that without which life itself is of no use to him—I mean light. If you will enable us to *see* London, I promise you that Art shall make it beautiful to look upon.

Have I said too much about the chimneys: well, then, let us turn for a moment to the gutter. For we must not be afraid of using rough words, if rough words are necessary to express our meaning. I speak as an artist. If in the utilitarian enterprise of sanitation there is a department which may be called the science of the gutter, there is in the exalted regions of idealism a department which may be called the art of the gutter. And this leads

me to my second point—that *the appliances necessary for the sanitation of our dwellings are not irreconcileable with the laws of beauty*. See how naturally the aims of the architect fall in with the aims of the sanitary engineer.

For instance, to take a case that comes particularly within my knowledge, In the building of a cathedral it is necessary to provide channels for the flood of water with which a sudden or heavy rainfall will deluge the roof. These channels are made to project in such a manner that the rush of water shall be carried outwards, away from the surface of the walls. But the architect who designs all this is not a builder only, but an artist also. Under his touch, therefore, the gargoyle, common in itself, and mean in its application, is ennobled by a secondary use. It is a gutter—but it is more than a gutter, as an architect is more than a builder. It is fashioned into some shape that shall add another beauty to the fabric. Into some shape — yes — but what shape? Shall it be derived from the flora or the fauna that give their wealth of loveliness to the sculptor's work in wood or stone? There is no link of association between these and the purpose to be fulfilled. Shall men and women bend downwards with mouths agape to scatter streams of water on the incautious passer-by? Their places are within the church. Shall the angels be made to fulfil this gentle office? Rather let them, with outstretched wings, bear up the fretted roof of the choir, looking down with mild eyes on the worshippers. But the fiends, the fiends that come with the night winds, bringing with them the fury of the storm. The fiends, that lurk in the miasma of foul air. The fiends, that clamour at the painted casements, which they cannot break, because the sword of Michael, with which he drave them out of heaven, flames there. The fiends, that rock the great steeple to its base, if only they may shake down the cross uplifted high in air. The fiends, that beat despairingly against the massive doors, strong with a strength beyond that of oak or iron. Transmute *them* into stone! Let *them* grin downwards on the happy throng which crowds the threshold they can never enter.

Now here is a strange thing. The very end and aim for which our cathedral is built is to make war against the Wicked One and all his hosts. And yet, just at the critical moment, when the architect is at a loss to deal with an essential part of his design—lo! of all things in Heaven and Earth and Hell—it is the "fiends" who come to the rescue. And why not?—if my third proposition be true, viz., that *in Art, as well as in Science, nothing is to be regarded as common or unclean if only it be in its right place*. Whether a gutter is in itself a thing of beauty depends upon the point from which it is viewed. Is the hippopotamus a thing of beauty? As he lolls against the prison bars of his house at the Zoological Gardens, with rolling eyes, and huge mouth opened wide for sweetmeats, it must be admitted that his shape is not elegant, and that his countenance is not attractive. But in his right place it is a very different matter. On the broad shores of the Nile, when the landscape is shimmering under the blaze of a tropical sun, when, as far as the eye can reach, there is nothing but the burning stillness of the vast solitude of vegetation without life—see! that mighty rush, as Leviathan passes to the water. See! the white foam lashed to the skies, and through it the purple and gold of his harness, iridescent with light, startled from its sleep upon the river. The sea-horse is himself again. Offer him a biscuit now!

It is thus that Art deals with Sanitation. The gargoyle, if placed upon a pedestal in a drawing-room, would not add a grace to the apartment. But in its right place—high up, that is, upon the cathedral roof, casting its deep shadows from the meridian sun, or touched by the silver of the moonlight—there it is as beautiful to the idealist, as it is useful to the utilitarian,

But the gargoyle serves another purpose. It serves to transfer our thoughts from architecture to Sculpture. The gargoyle is essentially the design of the architect, but it brings the sculptor into the game, who, mounted on high scaffolding, may still find work to do in the fretted roof or the crocketted spire. But the sculptor does not aspire to remain, like St. Simeon Stylites, always on so high a pinnacle. He would like, sometimes at least, to descend to the tympanum of an arched doorway, or the floreated capital of a column, or even to the pavement of the street, and show us what he can create in the shape of a lovely bas relief, an acanthus scroll, or a statue. But if he attempts such a thing, what will become of his work? What has become of the few works of sculpture that are supposed to adorn London? Do they not look as if they had suffered martyrdom at the hands of the street *gamins* on the fifth of November? They are abso-

lutely black with slime. *Is that the best thing you can do with them? If they are to be treated as guys, why should they not be made as guys?* That is my fourth proposition. The sculptor cries for help; who will save him and his work from this degradation? Who will give him the hope of a future? We look to you. When you have cleared our great city of its tenebrous pall, and given us light. When you have cleansed our temple, we will decorate its shrine.

And then Painting. What a glorious art it is, in its noblest form—that of mural decoration. And yet no Englishman who has seen Tintoretto's designs in the Ducal Palace at Venice, or Luini's great fresco in the church of the Angels at Lugano, or Raphael's decorations in the Loggiá of the Vatican, can feel otherwise than that we are cut off absolutely from at least one phase of Art, and that, as I have said, its noblest and grandest. But why? Again I say, it is not the climate that decimates our forces. It is the climate plus dirt.

What then is our hope for the future? Have we any hope for the future? My fifth proposition is that *any great scheme for the development of National and Historic Art in England is hopeless so long as this state of things continues.* This is a hard saying, but I will put it to the test by venturing to make a suggestion. I ask you to recollect the position that England has taken in the history of Art. You know that there have been two great periods of art — the Classic, which gave us the Parthenon, and the Gothic, which gave us Westminster Abbey. You know that the mastery in these two schools, each perfect in itself, and neither second to the other, belong to the people of Greece and to the people of England. The race of men who built our cathedrals are the equals of the race of men who built the Acropolis of Athens. We then, as Englishmen, have a past to look back upon, and ought to have a hope for the future. We are a nation with high aspirations, ready and strong to do great deeds which shall be worth recording. And we have painters capable of drawing pictures on a wall. Let the nation, through its representatives, choose the event, and the artists choose from among themselves the man who shall paint it. One pictnre every year—of the chief event of the year, or the most noble deed done, or the highest good achieved. In the choice of subjects there should be no boastfulness of petty princes blazoning their puny exploits. Nothing should be recorded that had not stirred the heart of the people. In the choice of painters there should be no voluntary display of raw ambition, or fashionable frivolity, or senile declension. They should be chosen by the suffrages of their fellow-painters, in their prime—so that their work would become in itself a true historic record, not only of the executive power, but of the collective judgment of each living school of Art, as it arose, flourished, and passed away. There is no genius of which the nation is proud that would be waste material, or might not take its share in the enterprise. The pencil of Leighton would not be too refined, nor that of Watts too serious, nor that of Millais too robust. Landscape, the glory of English Art, would find its place. Even the sculptor need not stand aside, for the sequence of glowing canvasses might be varied by a group or a bas relief in bronze or marble. The subject selected, and the name of the artist chosen, might be announced annually with the opening of the exhibitions of the year—and the artist should be allowed one year in which to complete his study or cartoon of the picture. Then his cartoon should be exhibited to bear the criticisms of the people. Few errors of historical importance would escape such an ordeal. Finally, the work should be completed by the artist, under no control save the influence those criticisms may have wrought upon his mind. There would be no risk of failure in such an enterprise. The events will come; the nation may be trusted for that. The men will come, some are with us even now, ready to begin the work. This would, indeed, be Historic Art, the marriage of Art with History. And think what would be the issue in ten years, in fifty years, in a century. We look with wistful eyes into the future, and picture to ourselves what we should see under such a scheme as this. Unless the future altogether belie the past, we should see such scenes as these.

The hospital at Scutari — the sick and wounded of our soldiers on their pain-stricken beds—and then—

> Lo! in this house of misery
> A lady with a lamp we see
> Pass through the glimmering gloom
> And flit from room to room.
> And slow, as in a dream of bliss
> The speechless sufferer turns to kiss
> Her shadow, as it falls,
> Upon the darkening walls.

It is "Santa Filomena." It is Florence Nightingale—herself—not an imaginary suggestion of what she might have been, painted

a hundred years after we had lost her, but she herself—

As if a door in Heaven should be
Opened, and then closed suddenly.

And then we see the interior of a class-room in London, with a few grave men, and thoughtful women, and the pale faces of many children—large-eyed, wondering children — who shall grow up to see themselves in this picture, and to know that they were painted there because the opening of the first Board school was a revolution, mightier in its results and more far-reaching than any that has yet been chronicled in England. And then we see the Senate-house at Cambridge, and the first girl-graduate receiving her degree, that shall acknowledge her to be as wise as Merlin, and leave her still as beautiful as Vivien.

We look for scenes like these because, although the past returns no more, yet the future shall be like it. Do we look for them in vain? That is a question that can only be answered by the nation.

Can be only answered by the nation did I say. Ah, no! *The nation cannot answer it, except through you. Who is there amongst you who will help to frame the answer. We wait for you.* Dear as are the remembrances of the past, splendid as are these visions of the future, we can do nothing to realise them without you. Our frescoes peel from the walls, our paintings blacken in the foul gas, our mosaics corrode before our eyes, our statues trickle down with greasy slime. But when you have cleared our great city of its tenebrous pall and given us light—when you have cleansed our temple—we will not be slow to make its shrine beautiful.

That, Dr. Richardson, is what I, representing a Society of Artists, have to say to you, representing the Society of Arts. We long for your city of Hygeia. We know that Science is working for us. The science of beauty greets the science of health. All that I have said of these three branches of the Fine Arts, architecture, sculpture, and painting, in association with our national monuments, is true relatively of every subsidiary development of Art. Science would cleanse the house and flood it with light. Art would cleanse the mind and fill it with beauty. And see how the two things, sweetness and light, which I call "the holy alliance," follow each other in natural sequence. Go into the dark little rooms of the labouring classes, and, if it is not, indeed, too dark to see, observe the dreariness of the surroundings of our poor. They toil and spin, but they are by no means arrayed like Solomon in all his glory; they work like the bees, but they are not—

"Singing masons, building roofs of gold."

How can Art penetrate to these dismal chambers? You know that in the old Mosaic dispensation it was forbidden to muzzle the ox that treadeth out the corn. Are we to be less careful for the labourers that contribute to our luxuries? How, I say, can we penetrate to their dwellings? We have our free galleries, and museums, thank God, in almost all our great cities. But I want to get closer home than that; I want to lift the door latch of the cottage and dreary flat, and the little parlour at the back of the shop; and I say, let sanitation lead the way, and Art will follow. Give them light, and they will at least see the dirt and the nakedness of their walls. Give them light and cleanse their walls; and the cheap print will follow. And the print, though it may be cheap, need not be nasty. As it becomes cheaper, it will become better. And they will become better and happier with it. For, with the sight of Art will inevitably grow the love of Art, and, with love, happiness; and happiness is, perhaps, one of the most powerful disinfectants the world knows.

That is the reverse side of the shield. The main purpose I have had before me has been to show how much may be done by a Society of Arts for a Society of Artists. But there is another aspect of the question to which I wish to refer before I conclude. I mean the return that Art can make. For, after all said and done, we may take it as certain that Art is, and always must be, one of the environments of our lives, that is daily shaping them to fair or foul issues.

Bad Art, therefore, means much more than bad artists. It means dreary surroundings in our dwellings; ignoble buildings in our streets; evil thoughts in our hearts. But the miserable hoardings of our railway-stations, plastered with hideous posters that crush our eyes as with a weight, forbidding us to raise them from the mud upon the ground; the blank walls and ungainly furniture of our houses that make mud in our minds—these are not necessary evils. It is we who have made them, and cursed them with ugliness; they only return to us the curse, in mental depression, with its inevitable tale of physical suffering. If the artist is interested in the work of the sanitarian, the sanitarian should be equally interested in the work of the artist. I know that the erection of a fine edifice on the north side of

Trafalgar-square, and the transfer of the Arch of Titus to the east end of the Strand, would not efface the calendar of crimes to be tried at the next assizes. But because Art cannot do everything, it is unreasonable to conclude that it can do nothing. It can at least do this. It can so transfigure a little colour that lies inert upon the palette, into a living presence, that our hearts shall beat faster only to look upon it. It can so link thought with thought and put them into sweet words that we may look through Shakespeare's eyes upon an English garden of three hundred years ago, or hear the storm-shaken pines which make music in the Volkslied, or see the shadow that lay dark on Danté's life as lies the shadow of the cypresses upon his grave at Ravenna. It can so build stone on stone, and shape them into beauty, that the architects of the thirteenth century shall speak to us of the nineteenth, making us stronger for our duty and happier in performing it. For Art stands alone in this, that it engages not some but every faculty of our being. Like the summer clouds that fill the sky, Art sweeps across our world, drawing into itself all our aspirations, all our scientific attainments, every tender emotion of our hearts. How beautiful are these summer clouds! Now ranged in lines like the battlemented walls of a distant city; now massed together like an army with banners; now drifting through the azure in a myriad of æthereal shapes, like a company of angels looking down on us from heaven. How beautiful is Art! in the splendour of its imagery, in its storms of passion, in its serene contemplation of things divine. But it is only Art; but they are only clouds. Does science say they are only clouds? How then are the furrows made soft with the drops of rain? And Art? Believe me, no tender thought, or noble aspiration, or high enterprise, is lost to us because Art fashions them into beautiful shapes. They come back to us, as the rain comes from the clouds, and they make our lives fruitful in faith, and wisdom, and love.

But the artist lives, and works, and dies, and his works perish with him. Why should they perish with him? That is the one question I press upon you. They need not perish with him. The time shall yet come when, if not the artist, at least his works shall be immortal.

DISCUSSION.

The CHAIRMAN said this was the first time, in the course of nearly 50 years, in which he had been engaged in sanitation, that he had heard the subject treated in the way it had been that evening. Sanitarians had been considered as men dealing with a very dry subject, which could scarcely be approached by an artistic mind; but they had now had put before them, for the first time in connection with it, the ideas of an artist who lived entirely in the world of beauty—an artist who went from one country to another, vistiing the most beautiful scenes and places; who passed into the very heart of the beautiful cathedrals he saw there; and then recorded his impressions in those beautiful pictures which, he doubted not, would live for ages, and carry his name down to posterity. It was not inappropriate that these two sides of the question should be brought forward in that room, for though the matters put forth by the Society from week to week were sometimes heavy reading, though instructive, yet the Society had beauty in it. If anyone asked where, he would say *circumspice*. Around those walls were displayed the works of a man of genius. Barry, who painted those pictures, lived on bread and apples—a truly humble-minded man—but he had left on those walls that which made them so beautiful. He believed the Society had done far more than it would otherwise have accomplished, in consequence of those beautiful pictures. If the room had had simply bare walls the work done would not have been so great. Mr. Bayliss did not claim to understand sanitation, but he came there bringing his artistic mind to bear on this side of the question; and looking at the paper carefully, it would be found that he put forward three main points. First, he wanted to make sanitary work, in its details, beautiful; secondly, to make the mind healthy, so that it could receive beauty as well as health; and, thirdly, he wanted sanitarians to preserve that beuuty which he and his compeers produced. Could sanitary work be made beautiful? He did not doubt it for a moment. All the sanitary work brought into houses and public buildings might be made as beautiful as he wished; and he hoped it would become so, now that Mr. Bayliss, as an artist, was ready to show the way. He had not been unmerciful in his criticisms; he might have said, with truth, that they had done nothing yet in that direction. They had thought too much of the mere fact of doing something useful, without thinking of the beautiful at all; of that exuberance which Blake called beauty. They had kept close to all details, which should be economical and practical only, and there had been the error. Mr. Bayliss had referred to the city of Hygeia, and he admitted that it was a very ugly place. When he wrote his description he was not inspired with any thought of putting before the nation anything but what was most useful. But he was quite ready for the artist to come in and modify the houses, temples, theatres, and railway stations, and do everything they liked to add to the foundation he had laid. It seemed to him a very hopeful thing that a great artist should come forward to show

that this could be done. Mr. Bayliss had shown that they had to educate the mind of the people through art to sanitation. That was a point which he (the chairman) and many others had dwelt upon. He had written an essay on health of mind, which bore entirely on this matter; for he knew the importance of educating the mind to entertain sanitary problems. In poor neighbourhoods the senses were never educated to anything beautiful, and that which the senses were brought up to see, feel, and hear, the senses held in the brain, and so the mind became accustomed to what was not beautiful or healthy, and adhered to it. So when you wanted to introduce any improvement, the answer was, "Our fathers and mothers, and brothers and sisters, were brought up in it, and why should we change?" It was like the man who had been so long in the Bastille that, when he was released, he had lost his power of appreciating the free air and sunshine, and wanted to go back to his prison. The mind became automatic with regard to ugliness as well as to beauty. Mr. Bayliss wanted them to go on first principles, and educate the mind so that it should yearn for that which was beautiful and healthy, for, as he had said, the two were really one. There could be no true health without beauty, and no beauty could exist without health. Then, thirdly, he said they must assist the artist by producing such conditions that their works could live. This was what sanitarians had not thought so much of. They had been thinking only of the living, breathing, human being—the animal—not of that which lived only through beauty, of those figures on the walls which lived, though they moved not; they had not yet dreamed of preserving them. But it was quite right; sanitarians ought to treasure up the dead which was beautiful as well as the living. Whether they could do so or not was the great question; but he thought they could. He did not doubt that whenever they were trying to make a place like Westminster Abbey continuously beautiful, and to preserve sculpture and pictures, they were trying to make themselves healthy. Go to any city on the continent, like Amiens, and see the cathedral; it was not more beautiful than Westminster; it only seemed so because there there was a pure sky and everything was clean. Could they bring back the atmosphere of large towns to such purity, that not only would people breathe better air, but that statues and cathedrals would retain all the beauty bestowed upon them? He thought they could. Take London as a centre with its smoke. It must be remembered that smoke was not altogether a bad thing, and until some great change was made it would not be a good thing to remove all the smoke from London. It was a great deodoriser; the carbon took up an immense amount of impurities and fixed them, and so purified the air, bad as it was in itself. What was wanted was not only to remove the smoke but to bring nature again into play, to let the circle be complete; to bring vegetation into London once more, and so bring more oxygen. The project, which he explained to the Society a good many years ago, was to make an upper London; across the street ways to run a beautiful bridge, and build terraces all along the roofs of houses, from the Marble-arch right down to Mile-end, on each side of the road, where there shonld be paths for foot-passengers, with plenty of trees and gardens. That would realise in some degree Mr. Bayliss's idea; there would be beauty in the gardens and also health, because the leaves of the plants would take up the carbonic acid, and yield back oxygen to the air, and there need then be no fear of removing the smoke. There might be vents to go down to the sewers, and if they were made exhausts, as they must be, every sewer itself would become a chimney, and London would be literally swept from the skies every hour of the day. He trusted these ideas of cleansing London would not be considered inartistic, and if the Society commenced a new era, in which art should be married to sanitation, they would effect a union which would, he hoped, go like a marriage bell, and make everybody in the future more contented and happy.

Mr. Henry Blackburn said at first sight it seemed as if these two ideas of art and sanitation were somewhat conflicting, but on thinking it over a little, it seemed to him that engineers had been doing for many years something towards this very matter of making art more popular in London than ever before. Just at present they could not have all these beautiful things along the tops of the houses, and probably they would not get them until a different fuel was used, and all the thousands of chimneys were got rid of from just the level where the pathways would be, but something was being done. The interiors of houses were being lit by electricity, and people understood much better the principle of lining interior walls with economical and bright tiling. They must now call on the artist to make a real study of the best kind of decoration for brightening the homes of the people. The thousands of students at South Kensington should not think only of painting on canvass, which in our atmosphere might be perishable, but should study more the science of decoration founded on the best models. Within a few yards, on the Thames Embankment, there was the obelisk, bearing a very interesting tablet of marble with an inscription which had become, by the action of the London atmosphere, almost illegible; and he thought if the County Council would consider the question of cleaning and brightening up some of the monuments we already had, it would be encouraging art in a practical way.

Mr. Hugh Stannus said he had listened with great pleasure to Mr. Bayliss's poetic, and even passionate, protest against the existing state of things in London; and he sympathised with the demand that architects and all other artists should be allowed to exist under better conditions for Art in

our great cities. They could not expect beautiful marble statues to last much longer under the terrible acid in the atmosphere, from which even bronzes were suffering. He desired also to thank the chairman for his address, which seemed to be the proper continuation of the paper. The reader made the demand, and the chairman had shown one way in which that demand could be met; and he hoped the paper, and the chairman's address, would receive the attention they deserved.

Mr. C. F. HAYWARD said the eloquent address they had heard was certainly practical, although it took its rise in the highest regions of poetry and imagination. One of the really practical ways of giving effect to these ideas would be whenever any improvement was taken in hand to see that it was carried out on the right lines. If they could not yet have delightful avenues along the tops of the houses, it was not impossible to have foliage in the streets, and to a certain extent that had been begun; and in a way which, in his boyhood, could hardly have been imagined. There was going to be a very great improvement in central London; the new street the County Council was proposing to make was to be a very grand thing in its way, and if properly backed up by public opinion, it would be only the commencement of something much larger, which might to some extent carry out the Chairman's idea. The street was to be 100 feet wide, and would have trees at each side, and there was no reason why spaces should not be left, with gardens and fountains, such as were not to be found anywhere in London, at present, which might form a model for the thoroughfares to come hereafter. Some time ago, in connection with the Society of Arts, Mr. Westgarth offered a large premium for designs for the improvement of London, many plans were sent in, and several prizes were awarded. Some of those schemes were very grand, in fact they were too grand, and nothing had come of them; but they seemed to be now entering on a more hopeful era, and if only public apathy could be overcome through the influence of enthusiastic gentlemen like Mr. Bayliss and the Chairman, something much better than had yet been imagined by ordinary people might be accomplished. In Paris, wherever there was a large street, a square, or open space was set apart for a garden with fountains, and seats. In London too many of the open spaces were enclosed by rails, and only accessible to those who subscribed for a key. The County Council were anxious to throw open Lincoln's-inn-fields, one of the finest squares in London, and, if they were supported by public opinion, no doubt it would be done.

Mr. W. BARRINGTON D'ALMEIDA had been much interested in the paper, but had hoped to hear some suggestion for getting rid of fog, which was one of the greatest enemies artists had to contend with in this country. He did not know of any other place in Europe where you could find finer open spaces and parks than in London, and there were beautiful gardens along the Embankment; but he did not know how the fogs were to be remedied. He did not suppose it could ever be got rid of altogether, considering the position of London in a valley with a river running through it; but it was the quantity of smoke issuing from the chimneys which made it so offensive. He understood that steamboats and factories had to consume their own smoke, and if a similar system was adopted for household chimneys, it would be a very great assistance to artists.

Mr. WYKE BAYLISS, in reply, said if anything at all were to be done, there were two things required, one, the determination that it should be done; and the other, the knowledge how to do it. As an artist, he did not approach the latter question; he only brought forward the imperative necessity of doing something. He showed the suffering caused to all who loved the beautiful, and the damage done to everything beautiful, and the impossibility of creating still further forms of beauty, unless the atmosphere could be purified, that in fact the most splendid development of art would be crushed out of a nation which ought to stand at the top in these matters. England had always taken the first rank in commerce, in literature, and in science. In poetry we did not simply stand side by side with other nations, but had the greatest man of all. The nation which owned Shakespeare need not hang its head in the presence of all the poets of the world. But artists were often unconscious that we could claim the same rank in art as in poetry; and this was most important in connection with the subject of the evening. In every single thing in which art had been great, ancient or modern, England had taken the lead. As architects, those who built our cathedrals were the men who established the splendour of Gothic architecture. Canterbury cathedral being built, was copied forty years later at Notre Dâme; Westminster, Lincoln, and the rest, had given the name to the style—Early English. But the position England took at the present day in the world of art was different. There was a great school in Paris; there was a great German movement in art; the Italians were beginning to move, and also the Spaniards, and in America sculptors had been heading the way. In ancient art the crown was held by Greece; in medieval art, in architecture by England, in painting by Italy. In modern art there were two phases, in which England stood in the highest rank; one oil landscape painting, in which Constable and others led and the French followed; the other water colour, in which England was at the top. Not only in the past then, but in the present England was capable of the highest development of art, but there was a bar against that development, and that was the condition of our atmosphere. He, therefore, pleaded as an artist,

that the Society of Arts should do what it could to help them in this matter.

The CHAIRMAN then proposed a hearty vote of thanks to Mr. Wyke Bayliss for his admirable paper, which he trusted would yet bear good fruit.

The vote was carried unanimously, and the proceedings terminated.

Miscellaneous.

CONDITION OF BRITISH HONDURAS.

The speech of His Excellency Sir Alfred Moloney, K.C.M.G., Governor, on the occasion of the meeting of the Legislative Council of the Colony of British Honduras, contained full particulars of the various proposals for the improvement of the internal communications of the colony, and of the attempts to develop its resources, from which the following notes are taken :—

As regards proposals that may be in the future made for the execution of works of unquestionable utility, such as railways, telegraphs, wharves, tramways, lighting, &c., on the expediency of which the Government may be satisfied, as well of the financial ability (of primary importance) of persons desiring to undertake such, I may explain that the Imperial Land Clauses Consolidation Act, 1845, consolidates in one law the provisions necessary in laws authorising the taking of lands, for undertakings of a public nature, so as to obviate the repetition of these provisions in any special law authorising any particular work or undertaking. The Imperial Act referred to deals with cases of purchase by agreement, of compulsory purchase, and with the application of the purchase money or compensation coming to parties under disability, and provides in fact, as nearly as possible, for every case that can arise in the acquisition of lands. The desirability and convenience of having such an addition to the local law will be obvious to you.

Here I may be permitted briefly to explain that the railway and cable questions engage the serious attention of the Government. With regard to the former, a survey was, as you are aware, begun in January last to determine the most feasible and economical route for a railway service to the frontier, and to illustrate it by working drawings. With the object in view of respecting and furthering the popular wish and want, to have Crown lands opened up in favour of settlement, the work was conducted from Belize to a point beyond Church Yard, and thence up the Sibun valley, when from the physical difficulties encountered, it was decided that continuity of survey further in that direction would be for the time a waste of time and money. It is now advanced that the Belize River route is the only possible one for a railway to the frontier. There has been completely surveyed, for a main line of railway in such direction, about $35\frac{1}{3}$ miles, as well as, I may say, $35\frac{1}{2}$ miles thence along the Sibun valley; work available, it is considered, for a branch line to enter upon and open up Crown lands. The correspondence on the survey work has already been communicated to you. I will only now add that a railway to the frontier, along the Belize River valley, would pass mainly through private lands; and that it will be necessary for the owners thereof to signify clearly in what proportion, and to what extent, they are prepared to contribute in the matter of any land grant to be given in payment of such a service. Whilst, generally and indirectly, a railway would unquestionably benefit the whole colony, the value of private lands along the Belize River would be enhanced very considerably indeed. Next, any money grant in aid, necessary, whether as an annual subsidy, or a lump sum, paid by instalments as work was completed, for which provision as to interest and redemption should be placed beyond question, has to be considered; and in the matter of land grants in aid by private owners, on the person contracting for any railway service, there should be imposed the obligation to make the necessary reservations for the establishment of townships, and to provide small agricultural holdings.

The labour question stands prominent, as of primary importance, and awaits solution. Local circumstances have not yet proved sufficiently attractive to initiate from the West Indies an ex-insular spontaneous immigration, even of the annual harvest kind that obtains elsewhere.

In view of the area of the colony, viz.: 7,562 square miles, and of its population at the time of the last census, viz., 31,471, which it has only reached from 25,635, at which it was returned in 1861, 30 years ago, there is little prospective encouragement in favour of future development, if it has to depend on the growth of its own people, who are now fully occupied, and that within the contracted area of activity prescribed by its own limited numbers. The population of the colony is admittedly inadequate to the development of its rich resources. It has occurred to the Government that the solution may be facilitated by the preparation of some scheme, on a legal basis, of immigration, non-Asiatic, the colony's circumstances not having reached such a stage as would justify the present entertainment of an Eastern immigration. Two Bills have been prepared, which will be submitted, and referred for the consideration and remarks of your Honourable Body. Such measures aim at providing for the establishment, at ports where immigration is favoured, of an Immigration Department, the appointment of emigration agents, the mode of application for immigrants, the allotment, on arrival, of immigrants, the distribution of

their cost, the labour, wages, and medical attention of immigrants, and right of repatriation, or commutation of such right for a grant of land; as well as on the payment of bounties in aid of cost of introduction of intending settlers, and free grants to them of town as well as plantation lots. The necessary reservations are being made to provide for such grants, and they will be surveyed as required. The principle of settlement here contemplated might, with advantage to themselves and the colony, be adopted by private landowners, whose co-operation in this direction is invited.

Under Chapter 58 of "The Consolidated Laws," provision is authorised to be made for the management of the ports and harbours of the colony. The concern and responsibility of the Government, the safety of the shipping, on which the import and export trade is dependent, the distance and importance of the principal lights that mark the approach to the colony, to its capital, and other ports, have suggested the expediency of adding to the keepers of the marine lights and of making provision for the appointment of a harbour master as a distinct officer, who would be held responsible for the efficiency of the light, buoy, beacon, and harbour service.

By means of the water carriage afforded by nature, in the form of rivers, the chief staple industries, mahogany and logwood—also nature's gifts—have been approached and developed. The advantages of such natural means of transport have favoured here, as elsewhere, plantations, which have constantly followed either the sea-coast or the banks of rivers, and, as with the wood industries, have so far scarce extended themselves to any distance from both. There yet remains the further opening up and development of the inland parts of the colony; its extent must depend on the growth of its population, and on the means of intercommunication and carriage.

Means of communication by land, and chiefly through private property, consist of mahogany truck and wing paths, of logwood "picados" and of the primitive forest single-file trails that connect such avenues and passages. Doubtless the interest of the colony will be served by the definite establishment of some road system, the expense, pretension, and expansion of which should depend mainly on what the commerce and general traffic of any particular district can afford to pay. By such a system roads would be completed, in time, both in nature and extent, as it may appear necessary and proper to make them, and they would be maintained.

No survey of even the means of communication existing, and the annual experiences of river floods which reached this year levels of 40 feet above what have been viewed as ordinary, and the wide expanses of land that are covered by their overflows, illustrate the difficulties of dealing with the situation, and dictate caution in respect to the pockets of the taxpayers.

It may be for your convenience I should recapitulate, approximately, by districts, the extent of the means of communication, such as they are. In Corosal District, it is estimated there are 94 miles, 22 main and 72 bye-roads and trails; in Orange Walk District, 267 miles, 69 main and 198 bye-roads and trails; in Belize District, 129 miles, 79 main and 50 bye-roads; in the Cayo District, 73 miles, 35 main and 38 bye-roads and trails; in Stann Creek District, 85 main and bye-roads and trails; and in Toledo District, 125 miles of main and bye-roads and trails. In respect to the current condition and future development of the colony, the initial step to be taken, in co-operation with landowners, suggests itself as a proper and complete survey of the existing means of communication, with a view to illustrate a basis on which a road system can be founded, and proceed, as regards expenditure on construction, extension, as well as provision for later maintenance and up-keep. To justify expenditure thereon, public rights of passage over the land so intersected should also be put beyond question, by express enactment, and by proof of dedication, whether based on gifts by the landed proprietors or usage. In furtherance of the advertisement of the local capabilities, there might proceed, *pari passu* with such a service, a geological and botanical survey, provision for which you may see your way clear to make in the estimates for 1893.

ARTIFICIAL INCUBATION IN EGYPT.

Artificial incubation, says the United States Consul-General at Cairo, is by no means a strictly modern industry in Egypt. The art of hatching eggs by other than natural process was known and practised by ancient Egyptians, and the Egyptian incubatory of to-day is but a reproduction of the one of thousands of years ago. The method of hatching eggs by artificial means, and a knowledge of constructing appliances for the same, have descended through ages from father to son. The incubatory is constructed of sun-dried bricks, mortar, and earth; and one which was inspected by Consul Cardwell was a structure 70 feet long, 60 feet wide, and 16 feet high. It is provided with twelve compartments, or incubators, each capable of holding 7,500 eggs, making a total capacity of 90,000 eggs undergoing incubation at one time. The season lasts only three months out of the twelve, beginning with March and ending with May; therefore allowing three weeks for incubating eggs and one week for removing each hatch and preparation for again filling the incubators with eggs, the number under treatment at this incubatory in one season may be placed at 270,000. From these are hatched 234,000 chickens. The per-centage of hatch would be much greater, but the eggs, being necessarily procured in large quantities and from distant places are largely damaged. Experience

makes the attendants of the incubators great experts, and in a very few days after the eggs are placed in the ovens the trained hand quickly detects the unvitalized egg, and the latter are at once placed upon the market at low prices for culinary consumption. Eggs are bought for the incubatory at a price never exceeding twopence half-penny a dozen, and chickens just from the shell are sold at less than sevenpence half-penny a dozen. After the incubators begin to turn out their product people come from all the surrounding districts, buying up the hatch and disposing of eggs in exchange for chickens. The oven crop of marketable chickens is estimated at 15,000,000 in one season, and estimating that one-fourth only of this amount die during their growing period, it may be stated that 20,000,000 is the hatch of the ovens. In the incubatory examined by Consul Cardwell, one man and a boy are the sole attendants. They live in the ovens night and day during the entire period of three months devoted to incubation, and the temperature surrounding them is never less than 98° Fahrenheit. The man and boy keep up the smouldering fires that create this temperature, they place the eggs in the ovens, move the great masses of eggs four or five times during twenty-four hours, look after the chickens, deliver them to buyers, and keep the incubatory in perfect order. As stated above, the incubatory is constructed of sun-dried bricks, mortar, and earth. The bricks and mortar are used in constructing the inner and outer walls, and earth is used to fill up the spaces between them. At the corner there is a door on one side, a window at the other, with close wooden shutters for both. There are five rooms, the first being a kind of reception-room, provided with a raised mud divan covered with rush mats. Here the buying and selling go on, while the mysteries of the incnbators are neither seen nor understood by the crowds who come to sell eggs or to buy chickens. A passage leads from this room past others, into which doorways open to another corresponding to it, except that the latter has no openings leading to the outside. In one of these rooms is stored refuse, finely ground straw, used for creating the fires in the ovens. All the walls rise to the same height, namely, 16 feet, and throughout the structure they are 2 feet thick. The spaces between the brick walls are filled with dirt, rising as high as the walls. Passing through what is little more than a man-hole, over which closes a wooden shutter, the passage leading between the ovens is reached. This is 50 feet long, with walls rising perpendicularly on each side to the roof. The ovens are square rooms, 12 feet each way, and are surrounded by brick walls, which begin to narrow when about 8 feet high, gradually drawing together until they form heat escapes, or chimneys, only 10 inches in diameter at their apexes, 1 foot above the roof. In the floor of each oven, close to the walls, and extending all round, is a groove moulded in the mortar. It is about 8 inches wide and 4 or 5 inches deep, and in this groove the finely-ground straw is burned, and maintains the temperature necessary for incubation. When once heated, the incubatory is made to maintain the requisite temperature with but little more expense of labour and fuel. To prepare an incubatory for the season of incubation, fires are kept burning in the fire grooves of the ovens for eight or ten days, expelling all moisture and heating the entire structure before eggs are placed in them. In this time the whole of the walls and floors become heated, and, after this first heating, a little fire every day in one or more of the ovens keeps the temperature at the incubating degree. The heating of the incubatory begins generally after the middle of February, and with March the work of incubation is in full swing. When the ovens are ready for incubation, the mortar floors are covered with finely ground straw, to the depth of two inches, and upon this are deposited the eggs. A passage way is preserved, from man-holes leading from the passage into the ovens to the manholes connecting the lower and upper ones, and the eggs are not brought into dangerous contact with the fire grooves round them. Laid two or three deep upon the straw, the eggs occupy the floor of the ovens between the central man-holes and the fire grooves, and four or five times in 24 hours are agitated by the attendant, who moves them eight or ten inches at a time from right to left around the entire circle. This movement is made with apparent carelessness, dozens of eggs being changed in position by a single move of the hand, and yet it is said that rarely is a single egg among a thousand cracked in the operation. For three weeks this treatment continues, and then the contents of the oven are changed from a white inanimate mass to a living host of chickens. Left for several days in the warm ovens, over the floor of which food is scattered for them, they gain rapidly in strength. The ovens are so charged with eggs as not to have them all hatch at the same time. Consul Cardwell says that there are incubatories in Egypt twice as large as the one described by him, and many smaller ones, and that to build one is not attended with great expense; the cost of the one described was less than £200.

General Notes.

Chicago Exhibition.—Mr. James Dredge, who has been nominated Hon. President of the International Engineering Congress, which will be held next summer, at Chicago, will be glad to hear from any members of the Society of Arts who propose to read papers at the Congress, or to attend it. Mr. Dredge will be happy to give information relative to the Congress to any members who may apply to him.

PRIZES FOR COACHBUILDERS.—The Institute of British Carriage Manufacturers offer the following prizes:—No. 1, for a brougham door, trimmed in any style, and plan showing fulness required; 1st prize, silver medal and £2; 2nd prize, silver medal and £1. No. 2, for cart, gig, or other driving cushion, finished with the straps in position; 1st prize, £2; 2nd prize, £1. No. 3, for the best painting of a coat of arms (with supporters); 1st prize, £5; 2nd prize, £2. No. 4, for the best painted crest and monogram; 1st prize, £2; 2nd prize, £1. No. 5, for a long seat box and French driving box, ready for trimming, a prize of £2. The age of the competitors for No. 1 must not exceed 35; for No. 2 must not exceed 28; for Nos. 3 and 4 must not exceed 25; No. 5 is confined to apprentices. The autumnal meeting of the Institute will be held at Aberdeen early in September, and articles in competition must be sent not later than Sept. 1.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

FEBRUARY 1.—WILLIAM KEY, "The Purification of the Air Supply to Public Buildings and Dwellings." SIR DOUGLAS GALTON, K.C.B., F.R.S., will preside.

FEBRUARY 8.—PROFESSOR W. NOEL HARTLEY, F.R.S., "On some Points in the Chemical Technology of Oil Boiling, with an account of a New Process for Preparing Drying Oils, for Decorators' and Artists' use."

FEBRUARY 15.—PROF. FRANK CLOWES, D.Sc., "The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air." SIR FREDERICK ABEL, K.C.B., F.R.S., will preside.

Papers for subsequent meetings, the dates of which are not yet fixed:—

"Transatlantic Steamships." By PROF. FRANCIS ELGAR, LL.D.

"Tele-photography." By THOMAS R. DALLMEYER.

"The Optical Correction of Photographic Perspective." By H. VAN DER WEYDE.

"Old Age Pensions." By T. MACKAY.

"Music in Elementary Schools." By W. G. MCNAUGHT.

"Technical Education: its Progress and Prospects." By Sir PHILIP MAGNUS.

"Locks and Keys, Ancient and Modern." By HARRY W. CHUBB.

INDIAN SECTION.

Thursday afternoons, at Half-past Four o'clock:—

FEBRUARY 16.—Sir WILLIAM WILSON HUNTER, K.C.S.I., C.I.E., LL.D., "The Progress of India under the Crown." The MARQUIS OF RIPON, K.G., G.C.S.I., C.I.E., will preside.

MARCH 9.—JERVOISE ATHELSTANE BAINES, I.C.S. (Bombay), "Caste and Occupation at the last Census of India." The LORD REAY, G.C.S.I., G.C.I.E., will preside.

APRIL 6.—The Hon. Sir EDWARD N. COVENTRY BRADDON, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisation."

APRIL 27.—Sir JULAND DANVERS, K.C.S.I., "Indian Manufactures." Sir ALEXANDER WILSON, formerly President of the Bengal Chamber of Commerce, will preside.

MAY 11.—Sir RAYMOND WEST, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results."

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock:—

FEBRUARY 28. — SIR EDWARD BRADDON, K.C.M.G., "Russia as a Field for Tourists."

MARCH 21.—CECIL FANE, "Newfoundland."

APRIL 18.—H. A. MCPHERSON, "The Philippine Islands."

MAY 2.—E. DELMAR MORGAN, "Russian Industrial Art."

MAY 18.—W. B. PERCIVAL, Agent-General for New Zealand, "New Zealand."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 7.—WILTON P. RIX, "Pottery Glazes: their Classification and Decorative Value in Ceramic Design." Sir HENRY DOULTON will preside.

FEBRUARY 21.—T. R. SPENCE, "Wall-papers and Stencilling." LEWIS F. DAY will preside.

APRIL 11.—PROF. PAUL SCHULZE, "History and Development of Pattern Designing in Textiles." THOMAS WARDLE will preside.

MAY 9.—W. M. FLINDERS PETRIE, "Primitive Art in Egypt." EDWARD J. POYNTER, R.A., will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

PROF. J. A. FLEMING, M.A., D.Sc., F.R.S., "The Practical Measurement of Alternating Electric Currents." Four Lectures.

LECTURE I.—JANUARY 30.—*The Measurement of Alternating Current Strength.*—Definitions—Graphic representation of periodic currents—Experimental description of current curves—Analysis and synthesis of periodic currents—Thermal ammeters—Electrodynamometers — Kelvin balances — Copper-disk amperemeter — Electro-magnetic instruments for alternating current instruments—Evershed's, Nalder's, Elihu Thomson's, Dobrowolsky's types of ammeters—Impulse dynamometers—Measurement of very small alternating currents—Methods of calibrating alternating current ammeters.

Prof. W. Chandler Roberts-Austen, C.B., F.R.S., "Alloys." Three Lectures.
March 6, 13, 20.

Lewis Foreman Day, "Some Masters of Ornament." Four Lectures.
April 10, 17, 24; May 1.

C. Harrison Townsend, F.R.I.B.A., "The History and Practice of Mosaics." Two Lectures.
May 8, 15.

Howard Lectures.

A Special Course of Six Lectures, under the Howard Bequest, will be delivered on the following Friday Evenings, at Eight o'clock:—

Prof. W. Cawthorne Unwin, F.R.S., "The Development and Transmission of Power from Central Stations."

Lecture IV.—February 3.—Hydraulic distribution of power—History of hydraulic transmission—Combination of water and power supply—Conditions of efficiency—Limitations—London system—Motors for hydraulic systems.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 30...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. J. A. Fleming, "The Practical Measurement of Alternating Electric Currents." (Lecture I.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. James Long, "Can the Empire Feed its People?"

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, $7\frac{1}{4}$ p.m. 1. Discussion on Mr. D. B. Morison's paper, "Marine Boiler Furnaces." 2. Mr. W. R. Cummins, "An Apparatus for Determining the Amount of Water Suspended in Steam."

Geographical, University of London, Burlington-gardens, W., $8\frac{1}{2}$ p.m. 1. Prof. J. Milne, "Journey Across the Island of Yesso." 2. Mr. A. H. Savage Landor, "Journeys Round the Island of Yesso and into the Interior."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. Arthur Cawston, "The Advisability of Undertaking the Improvement of the London Streets under a Comprehensive Plan."

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., $8\frac{1}{2}$ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Rev. Canon Benham, "The Emperor Justinian, and his Times."

Tuesday, Jan. 31...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "Functions of the Cerebellum and the Elementary Principals of Physico-Physiology."

Central Chambers of Agriculture (at the House of the Society of Arts), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Pathological, 20, Hanover-square, W., $8\frac{1}{2}$ p.m.

Sanitary Institute, Parkes' Museum, Margaret-street, W., 8 p.m. Sir Douglas Galton, "Ventilation, Warming, and Lighting."

Wednesday, Feb. 1...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. William Key, "The Purification of the Air Supply to Public Buildings and Dwellings."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m. Annual Meeting.

Archæological Institution, Oxford-mansion, Oxford-street, W., 4 p.m.

Thursday, Feb. 2...Royal, Burlington-house, W., $4\frac{1}{2}$ p.m.

Antiquaries, Burlington-house, W., $8\frac{1}{2}$ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Thomas Scott, "Report on the Entomostraca from the Gulf of Guinea, West Coast of Africa, collected by J. Rattray." 2. Mr. H. M. Bernard, "Two New Species of Rhax." 3. Mr. Arthur Lister, "On the Division of Nuclei in Mycetozoa." 4. Mr. J. E. S. Moore, "On the Structural Differentiation of the Protozoon Body, as Studied in the Microscopic Sections."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. A. E. Tutton, "The Connection between the Atomic Weight of the Contained Metals and the Magnitude of the Angles of Crystals of Isomorphous Series." 2. Professor H. E. Armstrong, "Note on Optical Properties other than Colour as Indicative of Structure." 3. Messrs. W. R. Dunstan and E. F. Harrison, "Contributions to the Knowledge of the Aconite Alkaloids IV. Napelline."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Henry Blackburn, "The Book of the Future."

Royal Institution, Albemarle-street, W., 3 p.m. Rev. Canon Ainger, "Tennyson."

Mechanical Engineers, 25, Great George-street, S.W., $7\frac{1}{2}$ p.m. Mr. R. Edmund Froude, "Description of the Experimental Apparatus and Shaping Machine for Ships' Models at the Admiralty Experiment Works, Haslar."

East India Association, 2, Westminster-chambers, S.W., $3\frac{1}{2}$ p.m. Lord Stanley of Alderley, "The Storage of Grain against Famine."

Friday, Feb. 3 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lectures.) Prof. Cawthorne Unwin, "The Development and Transmission of Power from Central Stations." (Lecture IV.)

United Service Institute, Whitehall-yard, 3 p.m. Capt. G. K. Scott-Moncrieff, "The Tactical Employment of Field Companies of Engineers in Combination with other Arms."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. Alexander Siemens, "Theory and Practice in Electrical Science."

Mechanical Engineers, 25, Great George-street, S.W., $7\frac{1}{2}$ p.m. Mr. William Matthews, "Description of the Pumping Engines and Softening Machinery at the Southampton Waterworks."

Geologists' Association, University College, W.C., $7\frac{1}{2}$ p.m. Annual Meeting.

Sanitary Institute, Parke's Museum, Margaret-street, W., 8 p.m. Dr. L. Parkes, "Water Supply, Drink-Water, Pollution of Water."

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, Feb 4...Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. Hubert H. Parry, "Expression and Design in Music." With Illustrations.

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FRIDAY, FEBRUARY 3, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 30th January, Prof. J. A. Fleming, M.A., D.Sc., F.R.S., delivered the first lecture of his course on "The Practical Measurement of Alternating Electric Currents."

The lectures will be printed in the *Journal* during the summer recess.

HOWARD LECTURES.

Prof. W. Cawthorne Unwin, F.R.S., delivered the third lecture of his course on "The Development and Transmission of Power from Central Stations," on Friday evening, 27th January.

The lectures will be printed in the *Journal* during the summer recess.

MULREADY PRIZE.

The Council of the Society of Arts are prepared to offer, under the terms of the Mulready Trust, a Gold Medal, or a Prize of £20 for competition amongst students of the Schools of Art of the United Kingdom, at the annual National Competition held in 1893.

The Prize is offered to the student who obtains the highest awards in the following subjects :—

(*a*) A finished drawing of imperial size from the nude living model.

(*b*) A set of time studies from the nude living model (mounted on imperial size mounts).

(*c*) A set of studies of hands and feet from the living model (mounted on imperial size mounts).

(*d*) Drawing from the life done at the examination on May 11th, 1893.

No student will be eligible for the award who does not pass in the examination *(d)* in drawing from the life, and who does not obtain an award for *(a)* the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The drawings, &c., are to be submitted, with other school works, in the usual manner to the Department of Science and Art, in April, 1893. Each competing drawing must be marked, "In competition for the Mulready Prize," *in addition* to being labelled according to the regulations of the Department of Science and Art.

Chicago Exhibition, 1893.

EXECUTIVE COMMITTEE.

A meeting of the Executive Committee was held on Monday, 30th January. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., M.D., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Sir George Hayter Chubb, Lord Alfred S. Churchill, Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Sir Henry Doulton, James Dredge, Sir Douglas Galton, K.C.B., D.C.L., F.R.S., W. H. Preece, F.R.S., Sir Owen Roberts, M.A., D.C.L., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

FINE ARTS COMMITTEE.

A meeting of the Fine Arts Committee was held at the Imperial Institute, on Friday morning, 27th January, to select the pictures sent in for exhibition at Chicago. Present: Sir Frederick Leighton, Bart., P.R.A., J. Macvicar Anderson, P.R.I.B.A., Wyke Bayliss, P.R.B.A., Philip H. Calderon, R.A., H. W. B. Davis, R.A., Sir James D. Linton, P.R.I., W. E. Lockhart, R.S.A., H. Stacy Marks, R.A., W. W. Ouless, R.A., Frederick Stacpoole, A.R.A., Marcus Stone, R.A., W. Hamo Thornycroft, R.A., with Sir Henry Trueman Wood, Secretary to the Royal Commission, and J. W. Beck, Secretary to the Committee.

Proceedings of the Society.

INDIAN SECTION.

Thursday, January 19, 1893; SIR THEODORE CRACRAFT HOPE, K.C.S.I., C.I.E., in the chair.

The paper read was—

THE CURRENCY PROBLEM.

By J. BARR ROBERTSON.

In a period like the present of widespread depression in trade and industry, and amongst the people generally, the question as to whether this can be traced to any special cause or causes is one of the highest importance. Numerous controversies have been, and are being carried on as to these causes, and out of the conflicting masses of argument and fact, of error and confusion, there is gradually emerging the cardinal idea that the predominant cause is the appreciation that gold has undergone in the last twenty years. In 1885 and 1886 a Royal Commission sat to inquire into the depression of trade and industry, but it practically failed to find any adequate cause for the troubles to which the inquiry extended. In its Third Report, however, the question of the altered relations between gold and silver was prominently brought forward; it was accepted as proved that the average prices of commodities in gold money countries had fallen, and that the gold price of silver had fallen, and it was stated that as this depression extended to other countries, and was therefore not the outcome of merely local causes or conditions, the appreciation of gold would be a cause sufficient to account for most of the phenomena into which they had been inquiring. And they recommended that a special Commission should be appointed to inquire into the recent changes in the value of the precious metals. But it is very important in passing to emphasise the fact that outside of the questions of the precious metals and the currency, no adequate cause was found to account for the depression.

Yet the depression was there to be accounted for, because the Commissioners were fully convinced of the extreme gravity of the situation. And since that time the conviction has deepened that the chief cause of the depression is the appreciation of gold. A special Royal Commission to inquire into recent changes in the relative values of the precious metals has collected a large mass of opinions and facts on the subject, and has found that the gold prices of commodities and of silver have undergone a very considerable fall, which is equivalent to saying that there has been a considerable increase in the purchasing power of gold over commodities and silver. It is, however, one thing to state this as a fact, it is a very different thing to make it so clear to popular apprehension that its full significance will be completely grasped and understood. It will be generally regarded as a truism that there is a great advantage in the prices of commodities being cheap. To buy things cheap, without any sacrifice of quality, is looked upon as one of the great objects to be aimed at in life. And when it is seen that there has been a fall in the prices of the leading commodities, it is often assumed that that ought to be a sign of prosperous times. If things are very cheap, then everyone can get so much more of them for the same money. What more, it may be thought, can be needed to bring home the conclusion that low prices are a great advantage, and correspondingly that high prices are a great disadvantage?

But when we come to look more closely at the subject we see that there are different kinds of low prices. We have low prices of grain, for example, as the result of an abundant harvest, or we have low prices of articles as the result of some economy that has been effected in the cost of their production. The prices of grain, and of these other articles, will therefore be relatively cheaper than those of others in which there has been no abundant harvest, no excessive supply, or no economy in the cost of their production. On the other hand, if there is a deficient harvest, or if some articles can only be produced at a greater cost than formerly, then the prices of the articles so affected will be higher. These changes—and they are going on and must go on continually—are relative changes, that is, some prices are higher relatively to a certain general level, and some are lower relatively to that level, and so prices rise and fall in endless diversity. These changes in regard to the prices of commodities are due solely to demand and supply in connection with these commodities. They are natural changes, and they are inevitable. They are not produced under any artificial conditions of restraint, they are produced under the complete liberty of mankind to use their best judgment in selecting and following up the most advantageous fields of production or of occupation that are available for the

application of their labour or their capital. Under such conditions of freedom, more will be produced of some articles relatively to the population than of other articles as compared with former years, and less will be produced of some articles than in former years. But all this is done under free judgment, free production or occupation, and free competition. Under this system one man may become rich or another man may become poor, but all have a free field and an open chance according to their means, their capacities, and their opportunities.

In this country we do not attempt to interfere with prices, however high or low, except in the few cases in which we impose taxation on articles for the purposes of revenue, and in these cases we tax the whole quantity consumed in the country. In every other country of the world, taxes are imposed for purposes of protection, and thus many of the natural prices, as we know them, are interfered with by the arbitrary system of tariffs for the protection of local trade and industry. Still, that does not prevent, nor should it, prices of commodities from rising and falling in obedience to demand and supply, as modified by the arbitrary effects of tariffs. So that, for our present purpose, prices under free trade and those under protection may be placed in the same category. The prices of individual commodities under either system rise and fall in accordance with distinct and ascertainable causes in connection with demand and supply.

But there is another class of low prices intimately mixed up with, yet originating in causes totally distinct from, the low prices of the system of demand and supply. The distinction between those two classes of low prices is one that is hardly sufficiently considered or understood by the general public. This confusion of two distinct things in the popular mind, and the neglect almost altogether of what, in currency considerations like the present, is by far the more important of the two elements, have hitherto formed an insuperable difficulty in the way of a popular apprehension of the momentous questions at issue. If we take the average prices of a considerable number of leading commodities year by year, we may find that these average prices have, as a whole, risen very materially over a period of years, or that they have fallen very materially. This will be more intelligible if we explain the system of index numbers of the *Economist* newspaper. The prices of 22 leading wholesale commodities were tabulated from the year 1845 to 1850, and the average price for these years of each article was called 100, so that with 22 articles the total index number was 2,200. On January 1st of each subsequent year, the prices were taken, and in each case the article was represented by a number above or below 100, according as the price had risen or fallen, and the sum of the 22 numbers was the total index number set down year by year. This total index number, therefore, merged all prices high and low in a single figure, and a glance indicated, year by year, how the general level of prices was moving, whether upward or downward.

Some articles might rise in price, and others might fall, but the total index number only showed how, on the average, and as a whole, the total prices had risen or fallen. Now, it will be evident that the prices that rose above the original 100 of 1845 to 1850 might have been balanced by those that fell below that figure; and so we might have had in the total no very great variation year by year from the original 2,200. So long as some prices go up, and others go down, we cannot say whether the purchasing power of our money is increasing or diminishing; but when we see the total index number going up or going down, then we know that our money is buying less or buying more of general commodities than it did before. The total index number of the prices of the 22 articles, from 1845 to 1850, was 2,200, but, in 1864, it reached its highest point, namely, 3,787; in 1870, it was 2,689; whereas, in 1886, it was 2,023, the lowest point since these figures were first tabulated. The meaning of this was that, in 1845 to 1850, certain quantities of the 22 articles could have been purchased for £2,200; in 1864 it would have taken £3,787 to purchase the same quantities; in 1870, £2,689; whereas, in 1886, £2,023 would have sufficed. From 1850, therefore, to 1879, gold had diminished in purchasing power, because it took £3,787, in 1864, and £2,689, in 1870, to purchase what only required £2,200, in 1845 to 1850. But, as in 1886 it only required £2,023 to do the same, gold had enormously increased in purchasing power, as compared with 1864 and 1870, and had considerably increased as compared with 1845 to 1850.

At this point, therefore, attention is again drawn to the distinction between a range of prices, some low and others high, following the conditions of supply and demand of the 22 commodities, and continually changing rela-

tively to each other, but in which the total index number does not vary much from year to year, and a range of prices continually changing relatively to each other, but in which the total index number has, for example, fallen from 3,787, in 1864, or 2,689, in 1870, to 2,023 in 1886. When the total index number is comparatively stationary year by year in this country, the purchasing power of gold over general commodities is steady; but when the total index number falls enormously between one period and another, then the purchasing power of gold over commodities has increased enormously; and when the total index number falls, for example, 30 per cent., that means that, in addition to the rise and fall in prices, due to the operation of supply and demand, there is a fall of 30 per cent. in all prices, both high and low, due to the increase in the purchasing power of gold. Starting at a given period, like 1845 to 1850, if the same proportion was maintained between the amount of money in circulation and the uses of the public for money, the same general level of average prices would be maintained.

But, if larger quantities of money flow into circulation from abroad, as was the case from 1850 till 1870 from the Californian and Australian gold-fields, then, while prices will rise and fall relatively to each other, the general level of prices will also rise in correspondence with the increased quantity of money in circulation, so that all the individual prices, high or low, relatively, will rise higher than they would otherwise have done. This is very strikingly exemplified by the course of prices during the influx of the gold from California and Australia. The 22 articles, valued, in 1845 to 1850, at £2,200, rose in price; so that, for the 8 years from 1858 to 1865, the yearly average was £3,038; during the 10 years from 1866 to 1875, it was £2,877; in the 10 years, 1876 till 1885, it was £2,419; in 1886, it was £2,023; on July 1st, 1892, it was £2,081; and on January 1st, 1893, it was £2,120. So that we see how this influx of gold raised prices, without any regard to the changes in relative prices, due to supply and demand, as affecting commodities; and at each of these periods the purchasing power of gold changed, until now average prices have fallen considerably below those of the exceedingly depressed times, before the gold discoveries in 1849 and and 1850. During the last 18 years, our supplies of gold have fallen off greatly, as compared with the period from 1850 to 1870, and the number of countries using gold money has considerably increased, and, consequently, our general level of prices has fallen very much, as shown by the total index number. The purchasing power of gold has correspondingly increased; and this will be more completely exhibited in Table 1, on p. 213. The object is to compare the various ranges of prices from a period before Germany began to demonetise silver and to adopt the single gold standard, up to the present time. The five years, from 1865 to 1869, have been chosen for this purpose; and the total index numbers during these years give an annual average of 3,102 for the 22 articles. In the Table, in order to render the movements of the index number clearer, we have taken 3,102 as equal to 100, and made the other calculations accordingly, so as to deal in percentages.

The figures in column 1 show the movements of English prices in the last 23 years. In 1886 they had fallen 35 per cent., and on January 1st, 1892, the total fall was 31 per cent., on July 1st 33 per cent., and on January 1st of this year 32 per cent. Therefore it is absolutely incontestable that between the first period and the last date in the Table, gold had so much increased in purchasing power that £68 would purchase the same quantities of the 22 staple commodities of the *Economist* as would have required £100 in the period from 1865 to 1869; and a glance at the Table will show the varying course year by year of the fall in prices.

Passing to column 2, we have here the *Economist* index numbers valued in bar silver in London at the current rates. After 1872 the quantity of silver that could have been bought for gold increased, and so commodities were worth a higher silver price than the gold price, as compared with the period before 1873. The gold index number and the silver index number both started at 100, and they continued the same until 1873, when the effect of the adoption of the gold standard by Germany, and the demonetisation of silver began to be felt, and after this France, and the other members of the Latin Union demonetised silver. In consequence of these movements, the gold valuation of prices and the silver valuation began to diverge from each other, until on January 1st, 1893, the gold valuation had fallen to 68, while the silver valuation stood at 107. This will perhaps be made clearer if we state that while at the end 68 ounces of gold would purchase as much of the staple commodities as 100 ounces at the

beginning of the period under review, in the case of silver 101 ounces would on July 1st, 1892, purchase as much as 100 ounces did at the beginning, and 107 rupees would purchase in London on January 1st, 1893, as much as 100 rupees did in the former period.

Table I.

	The "Economist" Index Numbers of 22 Leading Commodities.				Mr. Sauerbeck's Index Numbers.	
	Col. 1. Index numbers. Gold prices, January 1st. 100 = 3,102.	Col. 2. Prices in col. 1, as valued in London in bar silver.	Col. 3. Increase in purchasing power of gold, as shown by prices in col. 1.	Col. 4. Increase in purchasing power of silver, as shown by prices in col. 2.	45 leading commodities. Gold prices. Average of year.	Gold value of bar silver in London. Average of year. 100 = 60·84d. per oz.
			per cent.	per cent.		
1865 to 1869	100	100	par	par	100	100
1870......	87	87	15	15	96	99·6
1871......	83	83	20	20	100	99·7
1872......	91	91	10	10	109	99·2
1873......	95	96	5	4	111	97·4
1874......	93	95	8	5	102	95·8
1875......	90	94	11	6	96	93·3
1876......	87	95	15	5	95	86·7
1877......	88	93	14	8	94	90·2
1878......	81	91	23	10	87	86·4
1879......	71	87	41	15	83	84·2
1880......	82	95	22	5	88	85·9
1881......	77	91	30	10	85	85·0
1882......	78	91	28	10	84	84·9
1883......	75	90	33	11	82	83·1
1884......	72	86	39	16	76	83·3
1885......	68	82	47	22	72	79·9
1886......	65	84	54	19	69	74·6
1887......	66	87	51	15	68	73·3
1888......	72	98	39	2	70	70·4
1889......	71	101	41	—1*	72	70·2
1890......	72	98	39	2	72	78·4
1891......	72	90	39	11	72	74·1
1892......	69	95	45	5	68	65·3
1893......	68	107	47	—7*		
July 1, 1892	67	101	50	—1*	67·8	65·9
Oct. 1, 1892	66	105	51	—5*	66·8	62·7

* Decrease in purchasing power, that is, depreciation, of 1 per cent., 5 per cent., 7 per cent.

Now let us pause for a moment and estimate he enormous significance of this result of the novements in gold and silver prices during the ast quarter of a century. The foreign producer in a silver money country like India, sends his merchandise to London in competition with English merchandise, and sells it side by side with the English merchandise in

the same market, and it may be out of the same warehouse. The foreign and the English goods have been sold in London for a quarter of a century on exactly the same conditions, and at exactly the same price for equal qualities. But the English producer who began by getting £100 for a certain quantity of his produce now gets only £68 for every £100 that he formerly received; whereas the Indian producer, selling at the same gold price in London as the English producer, received on July 1st, 101 rupees for every 100 rupees that he received in the period from 1865 to 1869, and on Jan. 1st, 1893, he received 107 rupees. The consequence is, that with all conditions of demand and supply of commodities affecting equally both foreign and domestic merchandise, within a quarter of a century the domestic producer was receiving in July 33 per cent., and in January 32 per cent. less money for his merchandise in the London market than he received at the beginning of the period, whereas the Indian producer was receiving 1 per cent. more of his money in July and 7 per cent. more in January than he received in London at the beginning of the period. It must be remembered that we are dealing with commodities in this country, and not with exclusively Indian products, the object being to contrast gold prices and silver prices in the same market.

Further, it is most important to remark that the purchasing power of silver, the money of the Indian producer, had not depreciated in regard to commodities until 1892. A glance at column 2 will show that silver prices had fallen, that is, that the purchasing power of silver had increased during the whole period except in 1889, and on July 1st, 1892, when it required 101 ounces of silver to purchase what formerly required 100 ounces, and it is only since that time that a depreciation, amounting in all to 7 per cent., has taken place. So that in London silver prices have risen to a small extent. But gold prices which were on a par with silver prices up to 1872 are now 32 per cent. lower than they were in 1865 to 1869.

Passing now to column 3, it will be seen that, in its command over commodities, gold had increased in purchasing power to the extent of 54 per cent. in 1886, and to 47 per cent. at the end of the period. A sum of £68 will now purchase what formerly required £100, and in column 3 we see year by year the changes in the purchasing power of gold. In 1872 £100 would purchase commodities which, in 1865 to 1869, would have cost £110, in 1882 it would purchase £128 worth, and in 1886 £154 worth. On 1st July, 1892, £100 would purchase what would have formerly cost £150, and on 1st January, 1893, what would have formerly cost £147.

While it is almost universally stated that silver has depreciated, a glance at column 4 will show that, except on three occasions, silver has during the last twenty-three years been appreciated. In 1872, silver and gold were together, and 100 ounces of silver would purchase as much as 110 ounces would have purchased in 1865 to 1869; in 1882, the 100 ounces had also a purchasing power of 110 ounces; in 1886, of 119 ounces; and on July 1st, 1892, the 100 ounces had a purchasing power of 99 ounces; and on January 1st, 1893, of 93½ ounces of the value from 1865 to 1869.

In corroboration of the fall in the gold prices of commodities, we are indebted to Mr. A. Sauerbeck for the index numbers of forty-five leading commodities in London which are included in the foregoing Table. The final results are almost exactly the same as those of the *Economist*. His figures for the period from 1865 to 1869 average 100, and his figure for 1892 is 68 against the 69 of the *Economist*, on January 1st, 1892, and 68 on January 1st, 1893. Mr. Sauerbeck's figure for September is 66·8; and this he declares to be the lowest touched during this century.

A further fact has now to be recorded. The gold price of silver fell during the period under notice, from 60½d. to 40⅝d., on July 1st, 1892, and this was a fall from 100 to 66·4, while commodities fell to 67: so that here we have the extraordinary result of the *Economist's* 22 commodities, Mr. Sauerbeck's 45 commodities, and bar silver in London, all steadily falling for a quarter of a century, and in July, 1892, all arriving at practically the same point, namely, 67. Considering the immense field for variations, the correspondence between the three was something which we could hardly have regarded as possible. But it is a striking evidence of the extraordinary stability of silver in its purchasing power over commodities as compared with gold during such a long period, and of its steadiness as a standard of value. On the other hand, the fall in the gold price of commodities, and of silver, to the extent of 32 per cent., is an equally striking evidence of the instability of gold during the same period, and of its entire unreliability as a standard of value.

In considering the movements of gold prices and silver prices it has been thought better to take the articles as valued both in gold and in silver in London, and so we have recorded the figures as if both a gold currency by itself and a silver currency by itself were in operation in this country. It is most important to point out that the difference between the index number of gold prices and that of silver prices is solely and exclusively a difference of currency. It is so often stated when comparing gold prices and silver prices in separate countries that there are many disturbing elements to be taken into account, that both gold and silver prices in London have been expressly calculated so as to make an exact comparison of the action of gold and silver on prices in the same market where there are no disturbing elements.

But while the limits of our space forbid the presentation of the details of the 22 commodities separately, there is one paramount article of production, both in this country and in India, the particulars of which it will be highly interesting to present in some detail. I refer to wheat. There has recently been a lengthened correspondence in the *Times* on wheat-growing, and the profits and losses arising therefrom; and in this controversy the leading agriculturists of the country have explained their view, although it does not seem that they propounded any available remedy for the extraordinary depression in the prices of grain. In fact, they have failed to give any account of causes sufficient to produce the depression. It is believed, nevertheless, that the principal cause of the troubles from which our agriculturists are suffering can be shown. The following Table gives the movements in the prices of Indian and British wheat since 1873. The Indian figures are taken from the Government of India's publication, "Prices and Wages in India," 1892, p. 125. The prices of the two classes of wheat for January, 1873, have been taken as 100 in the official tables, and the gold prices are calculated from the table in the *Economist*. It may be explained that the index number of the latter for wheat was taken at 100 for the period from 1845 to 1850; that in 1865 to 1869 the average of the five years was again 100; and that in 1872 and in 1873 it was 104. In the following Table, for the sake of exact comparison with the Indian per-centages, the 104 of the *Economist* in 1873 has been taken to be equal to 100, and the other figures calculated accordingly:—

Table II.

Indian and British Prices of Wheat.

Year.	Bombay Prices.		London Prices.	
	Col. 1. Khandwa Seoni, January.	Col. 2. No. 1 Soft White, January.	Col. 3. The *Economist* Gold Prices. January 1st.	Col. 4. Col. 3 valued in Bar Silver
1871	57	87	96	96
1872	87	86	100	100
1873	100	100	100	101
1874	77	75	111	114
1875	74	80	77	81
1876	76	84	81	85
1877	90	93	93	98
1878	106	119	94	106
1879	131	116	72	87
1880	137	115	85	98
1881	82	95	79	93
1882	81	97	81	94
1883	88	87	74	89
1884	66	86	70	84
1885	66	74	58	70
1886	81	80	55	70
1887	97	89	63	84
1888	100	86	56	76
1889	103	95	55	78
1890	90	84	54	73
1891	93	87	59	73
1892	118	103	67	93
Average of 22 years, 1871 to 1892.	91	92	76	85
July 1st, 1892.	—	—	57	86
Jan. 1st, 1893.	—	—	47	74

The average price of Indian wheat during the 22 years, with 100 as the price for 1873, was 91½ for both classes, and in January, 1892, the two classes stood at 118 and 103 respectively. On January 1st, 1892, the London gold price, which in 1872 and 1873 was at 100, had fallen to 67, on July 1st, 1892, it had fallen to 57, and on January 1st, 1893, as low as 47. But, when the silver price in London is examined, it is seen that it stood at 100 in 1872, the same as the gold price; and when the latter stood, in January last, at 67, the silver price was at 93; and when it fell further, in July, to 57, the silver price was at 86, though now the prices are respectively 47 and 74. On the other hand, the average silver price of the 20 years was 88, as compared with the Bombay average of 91½, and this higher price in India might be partly accounted for by the fall during the period in freight and other charges from Bombay to London. But it is not expected that there should be an identical price as between Bombay and the silver valuation in London, because the wheat is valued in

markets widely apart and with great opportunities of practical variation in price in connection with the varying charges of transfer to London as well as in connection with local conditions of demand and supply in India itself. But it is none the less satisfactory to find that the silver price in London is only 3½ per cent. less than that in Bombay on an average of the last twenty-two years, and it must be remembered that any decrease in charges between Bombay and London would add to the price in Bombay. As it might possibly be thought that this difference is in some way connected with the ordinary shipping charges, it may be well to point out that the Bombay prices and the English gold and silver prices all started at 100, and thus the Bombay price would only be affected by economies in transit charges.

In the above Table, column 3 represents the gross returns to the British wheat-grower, and column 4 represents the gross returns in silver in London to the Indian wheat-grower. The English grower and the Indian grower both started in 1872 by getting 100, but by 1886 the former was only getting £55 for the quantity of wheat that in 1873 brought him £100, while the Indian grower in 1886 was getting 78 rupees for what had formerly yielded him 100 rupees. On July 1st, 1892, when the English grower was only receiving £57 instead of £100, the Indian grower was receiving 86 rupees as against 100 in 1872. The Indian grower who started in 1872 by getting the same price as the English grower, received in July 1892 in London 51 per cent. more in his money than the English grower received in his, and on January 1st, 1893, he received 57 per cent. more. If the English currency had been of silver and the Indian currency had been of gold, then their positions would have been reversed. The English grower would in that case now be receiving £74 where he receives but £47, and the Indian grower would be receiving but 47 rupees where he is really receiving 74. And it must be recollected that silver, so far from being depreciated in purchasing power as against wheat is considerably appreciated, that is in July the Indian grower only received 86 rupees in London for wheat which in 1873 brought him 100 rupees, though on January 1st, 1892, he received 93 rupees, so that no claim whatever can be made that the difference is due to the depreciation of silver. In fact the figures in both of the foregoing Tables show beyond the possibility of being successfully disputed, that silver, as regards its purchasing power over the 22 commodities and over wheat, has been greater in nearly all of the last 22 years than in 1865 to 1869, but gold is shown to have increased in purchasing power to a far greater degree than silver. In England and in India therefore we have two distinct currencies which have both appreciated in purchasing power over the leading commodities, but the index number of the silver valuation in London of the 22 commodities, though at the beginning of 1892 not up to the level at which it stood 20 years ago, had nevertheless on July 1st just reached 1 per cent. above the former level, and on January 1st 7 per cent., after remaining during nearly the whole period below it.

Now a great deal is said of the competition of wheat from the plains of Russia and India, and from the prairies of the United States. It is so evident that very large quantities are being poured in at every harbour, that most people accept this fact as conclusive that that is the cause of the low prices in this country.

So far as the United Kingdom is concerned, the following Table will show certain figures of very great importance in this controversy:—

TABLE III.

WHEAT.—UNITED KINGDOM.
PER HEAD OF THE POPULATION

	Net Imports per annum.	Home produce per annum.	Total foreign and home produce per annum.	Gazette price. per quarter.	
	lbs.	lbs.	lbs.	s. d.	
Average of 8 years, 1872-79 ...	184·68	172·77*	357·45	51 2	
1884	191·57	144·75	336·32	35 8	
1885	237·87	139·33	377·20	32 10	
1886	187·79	109·93	297·72	31 0	
1887	223·63	131·26	354·89	32 6	A fall of 36 per cent.
1888	223·49	127·30	350·79	31 10	
1889	219·03	128·65	347·68	29 9	
1890	226·38	127·79	354·17	31 11	
1891	244·06	124·58	368·64	37 0	
Average of 8 years, 1884-91 ...	219·23	129·20	348·43	32 10	
1st Jan. 1893	—	—	—	25 8	

* This figure 172·77 is calculated from Lawes and Gilbert's figures in "Journal of the Statistical Society," vol. 43, 1880, p. 330, while the 184·68 is calculated from figures in the "Statistical Abstract." The net imports from 1884 to 1891 are from the "Statistical Abstract," and the home produce is calculated at 63 lbs. per bushel from Tables given there. But there are no official figures for the home produce of wheat before 1884, and Lawes and Gilbert's only come down to 1879. This is the reason of the gap from 1880 to 1883.

It will thus be seen that in the eight years, 1872-79, the total quantity of wheat consumed in this country was 357·45 lbs. per head of the population, at the average price per quarter of 51s. 2d., whereas in the eight years, 1884-91, the consumption per head of the population was only 348·43 lbs., and yet the average price was as low as 32s. 10d. This was a fall on the average of 36 per cent. Can it possibly be that with a less consumption, that is with less wheat sold in the markets of the United Kingdom in the latter period than in the former, there can be any contention that the smaller supply per head of the population could only bring 32s. 10d., while a larger supply in the earlier period should bring 51s. 2d., if the cause was only one of supply and demand? These figures are conclusive that the fall in price is not really due to excessive supply, because there was no excessive total supply. It is true that the foreign wheat has increased very considerably in the latter period, but the total amount has not increased, and, therefore, if the question were one solely of demand and supply, why should the price have fallen at all?

If a clear indication were wanted as to excessive supplies of wheat as compared with other commodities, reference might be made to columns 1 and 2 in Table I., and to columns 3 and 4 in Table II. It will be seen that in the former Table 100 is the average of 1865 to 1869, and as we have already explained, the *Economist* index number for wheat from 1865 to 1869 is 100, and the figure for 1872 and 1873 is 104, which, however, was changed to 100, so as to bring the comparison in exact line with the Indian official figures for 1873. But taking January 1st, 1892, in Table I., we have the 22 commodities standing at 69 for gold, and 95 for silver, and if in Table II. the difference between 100 and 104 is added, so as to make comparison of 100 for wheat from 1865 to 1869, then the special wheat figures will be 70 and 97 for gold and silver respectively, on January 1st, 1892, against 69 and 95 for the 22 commodities. This clearly demonstrates that wheat at that date was rather higher in comparative price than the average of the 22 commodities, and therefore that the wheat grower, grievous though his troubles might be, was slightly better off as to his relative price than the other producers in the leading industries of the country. Since then wheat has, however, fallen much more than the average of the 22 commodities.

When the relative positions of the Indian and English growers of wheat are compared, though they both sell at the same relative price in London, the Indian has an immense advantage in one thing, and only one thing: he has a currency rather appreciated in the last quarter of a century, but still that yields him now, in silver, 57 per cent. more of his money than the English grower is getting in gold, as compared with prices ruling from 1865 to 1869. He does not sell at a very low price in his own money, as we see he was getting 97 rupees in January, 1892, against 100 rupees twenty-five years ago. If the English grower could only have got £97 at the beginning of 1892, and been on the same footing as to present and past returns as the Indian, it is perfectly certain we should not have heard anything of excessive competition; but where the English grower has been so grievously injured is, that while the prices of wheat have fallen to such a low point in 25 years, his rent, wages, and other expenses have not fallen in a corresponding degree, or, rather, they did not fall as the price of wheat fell. He has been taught, by leading authorities on this question, that the fall has been due to bad seasons, to excessive competition from abroad, and to other causes; and he has been led to hope that the present state of things will, if let alone, right itself, and another era of prosperity soon spring up. But it is a fact that the yield of wheat per acre in all the wheat-growing countries of the world beyond these shores is gradually diminishing, and the populations of the world are nearly all increasing, and some of them very rapidly, and thus requiring larger supplies of wheat. When, however, the English grower sees, in the midst of his adversity, and at a time when he regards wheat growing as something almost to be despaired of, that the Indian grower is in the enjoyment of a much higher relative price and a very high degree of prosperity from his wheat fields, the former will perhaps begin to think that it cannot be wheat growing that is so unprofitable that there must be some other cause apart from occasional bad seasons, or from the demand or supply of wheat throughout the world, with which the English grower has to contend, and from which the Indian grower is free.

The Causes of the Fall in Gold Prices.

The question thus naturally arises as to the cause or causes that have led to this fall.

Judging from the operation of the laws of supply and demand, one might expect to find that there is less gold in circulation compared with the transactions in which gold, or money on the gold standard, is required, than was the case twenty-five years ago. It can be said with positive certainty that if there had been more money in circulation in the gold standard countries during the last twenty-five years, prices would have been higher, indeed prices would have been maintained at the level of twenty-five years ago if there had been money enough to effect that object. And therefore conversely, if average gold prices have fallen, it is because the supply of gold in the gold money countries has fallen off relatively to the transactions requiring the use of money. This will very probably be disputed, if one may judge from the writings of latter-day commentators on the currency, though hardly any proposition in the whole field of monetary science has had such conclusive practical illustration in all countries and all ages, and been so universally accepted. There are the words inflation and contraction of the currency to describe the phenomena referred to, and it will hardly be doubted that abundance of historical examples of both conditions can be found, and at present the Indian rupee is at approximately the same level of purchasing power as it was 25 years ago, yet its former gold price was 1s. 11d., and it is now 1s. 3d. But while the gold price of the rupee has thus fallen so much, gold prices of commodities in this country have also fallen very greatly. On the other hand prices in the Argentine Republic, to take one example, are enormously inflated, and so we have before us as compared with the period from 1865 to 1869, stable prices in India, low prices in England, and high prices in the Argentine Republic, all in accordance with a stable currency, a contracted currency, and an inflated currency. When the civil war closed in the United States, prices in greenbacks were very much higher than in gold because of the excessive quantity of paper money in circulation, but in 1879, when specie payments were resumed, the difference between gold prices and greenback prices had disappeared. The cause of this disappearance was partly the contraction of the paper currency, and partly the increase of population and of business requiring more money. Chili has just raised money by loan to enable it to withdraw part of its paper money, and thus reduce the volume of its currency so as to bring it to the level of gold, the paper currency having been over issued in nominal amount as compared with the gold standard, and thus depreciated below the level of gold, that is, causing prices for commodities in paper money to be higher than in gold.

The Indian Government are considering whether they should not raise the gold value of the silver rupee by suspending the coinage of silver, that is, by contracting the silver currency until the rupee rises to the fixed gold price. The quantity theory of money is so perfectly recognised in practice, that the Indian Government do not for a moment doubt that the contraction of the rupee currency would raise the gold value of the rupee.

But in estimating the causes of the fall in the gold prices of commodities, we are confronted with the opinion expressed in Part II. of the final Report of the Gold and Silver Commission by the members who favoured monometallism as follows :—

"We believe the fall [in the gold prices of commodities] to be mainly due, at all events, to circumstances independent of changes in the production of, or demand for, the precious metals, or the altered relation of silver to gold."

This passage is quoted in the *Economist* of October 29, 1892, to confute Mr. A. J. Balfour's contention in his speech at Manchester on October 27 last, when he said :—

"And can we claim that great quality for a standard [namely, 'as a permanent record of the debts and obligations lasting through long periods of time'] which, by the admission even of the monometallists themselves, has appreciated in some 15 years no less than 30 or 35 per cent., and of whose appreciation no man living under the existing system can prophesy the limits ?"

We find, also, the same passage doing duty in the Indian Press and with the Indian Currency Association in a way that brings it down from the region of mere fugitive theory to the decisive test of a proposal to apply it to the case of the Indian currency. Accepting and following up the views quoted above from the Monometallic Commissioners, they argue thus :—

"It is reasonable, therefore, to infer that the introduction of a gold standard will not injuriously affect prices in India, as suggested by the Currency Association, especially if the change be gradual."

This proposal is perfectly reasonable, if the Monometallic Commissioners are right in say-

ing that the fall in gold prices is mainly due to circumstences, independent of changes in the production of a demand for the precious metals. If the fall in gold prices has little or nothing to do with changes in regard to gold and silver, then the argument is unanswerable, that a contraction of the Indian currency and a rise in the gold price of the rupee will not injuriously affect Indian prices. To carry this argument to the concrete case proposed in India—namely, to suspend the coinage of silver, and gradually by this means contract the currency, until the rupee shall be worth 1s. 6d. or 1s. 8d., instead of 1s. 3d., as at present, the contention of the Monometallic Commissioners being that, as the fall in the gold prices of commodities and of silver is mainly due to circumstances, independent of changes in the precious metals, the Indian advocates of a gold standard say, therefore, that the rise in gold price of the rupee will be independent of changes in the precious metals, and will not be attended by any material change in Indian prices; and thus the contraction of the rupee from 1s. 3d. to 1s. 8d. can be carried, with little change, and with perfect safety. This would be, however, to assume that 1s. 8d. is the same as 1s. 3d.; while a glance at a table of cost of Indian commodities laid down in London would at once show that, with a fixed gold price in London, and a change in the rupee from 1s. 3d. to 1s. 6d. or 1s. 8d., the price of an article in India must be correspondingly lower. When we come to positive figures, imaginary conditions must give way.

We must, therefore, protest emphatically against this dangerous doctrine, promulgated by the conservative monometallic members of the Gold and Silver Commission, because in the whole report this is the only really dangerous doctrine which receives any commendation. But our friends in India have already given it a serious blow, by proposing to act upon it, because we may feel perfectly assured that no statesman, either in India or in this country, would for a moment approve of any attempt to take the risk of such a step being followed by little or no change. If a gold standard or a gold currency is to be introduced into India, it will be on the ground that every change in the volume of the currency relative to the business in which currency may be required, shall make a change in Indian prices. If the gold price of the rupee is to be raised by suspension of the rupee coinage, Indian prices must fall in a corresponding degree, and it is for those interested in Indian prices to say whether they are prepared for such a fall. The question of a gold standard for India is not at present being discussed, and it is only touched upon here as illustrating the action on prices of changes in the volume of a country's currency. The present point is, therefore, to emphasise that no Indian or British statesman will venture to recommend or adopt for India a monetary policy which does not take into account the quantity theory of money as the sole, or almost the sole, instrument in producing changes in the average prices of commodities.

Changes in the volume of money, or in the transactions to be carried out by money, have as complete an effect on the prices of commodities as changes in the supply of and demand for commodities. Two distinct things are being dealt with—money and commodities—and both are widely distributed over the world. There are from time to time changes in the quantity and in the uses of money, and there are also changes in the supply of and in the demand for commodities; but whatever their independent fluctuations may be, there is always a relation between money and each commodity, and this relation is expressed in the price of the article. There is, however, a distinction to be drawn, namely, that while each commodity is only one of an almost innumerable variety of articles to which a price is always attached, the one article money is always being offered against, and measured against, all existing commodities. So while at any one time the money of the gold standard, for example, has only one value, or one purchasing power, the commodities in which it is valued, and to which it affixes a value, have as varied a price, or purchasing power, as against money, or against each other, as there are commodities in existence. Thus money is being continually measured against all purchasable articles, and its purchasing power is thus tested and adjusted daily and hourly to thousands of articles. But each of these articles being only one in thousands, it is impossible that each separate commodity should as rapidly and exactly adjust the changes in its price to the changes in demand and supply in regard to the article as is the case with money, which is all the time measuring itself against all commodities, and thus keeping the volume of money in circulation continually and completely adjusted to the transactions to be carried out by money.

It would be strange indeed if demand and supply could regulate the prices of thousands of articles, and that yet demand and supply in regard to the single article money, in which they are all valued, should not have a corresponding influence. The truth is, that from the necessities of the case, demand and supply are more potent and more rapid in their action on the one universal article money than they are on the varying prices of numerous commodities. Money is seeking for and measuring commodities, and commodities are seeking for and measuring money, and so there is continual competition between them. They are both subject to the conditions of supply and demand, and to those who doubt this, we would take a homely illustration and ask, which of the two limbs of a pair of scissors does the cutting? There are two limbs essential to one operation, namely, cutting, and there are two conditions, the volume of money and the volume of transactions to be performed by money, essential to the price of one or of all articles. It is true that one limb of the scissors may be sharper than the other, and may thus contribute more to the cutting; and it is also true that the volume or purchasing power of money is more active in adjusting itself to changes in supply and demand than a vast number of commodities can be with their endless fluctuations, because the purchasing power of money over commodities is the average of all these fluctuations.

In support of this undoubted fact of the greater sensitiveness of money to changes in its volume and uses, that is, to its supply and demand, than of commodities to changes in supply and demand, we might instance the effect produced at the Bank of England by the arrival of £2,000,000 or £3,000,000 of gold. If the internal trade of the country is not in a position to absorb it, the bank is forced to lower its rate of discount until, by means of the foreign exchanges, the gold is drained away. The effect of the arrival of the gold is clear and unmistakeable, and its departure is equally so. And if we take gold bullion or coin as an article of international trade, there is no other article in the whole field of commerce that is so mobile, whose exact value in the markets of the world is so well known from day to day as gold, because it is the material of the standard money of the leading nations of the world. Of all articles of commerce gold is bought and sold by bullion dealers at the narrowest margin of profit; it moves from one country to another at a smaller advance in price than any other article of commerce, and it moves with a rapidity that no other article in practice can equal. The variations in the price of gold are minute, but it is more sensitive to a small change in price than any other article. The consequence is that there is no article so completely adjusted in purchasing power to its supply and its uses as gold. If the gold prices of commodities fall unduly in the United States, gold will at once flow by the fastest mail routes to take advantage of the low prices; but if the gold prices rise unduly in the United States, commodities can only be moved to these markets after considerable delay, to take advantage of the high prices. It is incontestable, therefore, that money is far more mobile than commodities, and is more easily and completely adjusted in its volume to its uses than commodities are to changes in demand and supply. The consequence of this is that, other conditions remaining the same, the average prices of commodities will fall in proportion to the contraction of the volume of the currency in which they are valued.

Table IV.

Production in the World of the Precious Metals.

		Gold. Per annum.	Silver. Per annum.	Total Gold and Silver. Per annum.	Silver purchased by the United States & coined into dollars or held in bullion, and thus used as gold, per annum.
		£	£	£	£
1846.........		5,850,000	6,500,000	12,350,000	—
1850.........		18,650,000	8,800,000	27,450,000	—
Periods of five years.	1852-56	29,880,000	8,120,000	38,000,000	—
	1857-61	24,720,000	8,300,000	33,020,000	—
	1862-66	22,700,000	10,060,000	32,760,000	—
	1867-71	23,700,000	10,520,000	34,220,000	—
	1872-76	22,040,000	13,460,000	35,550,000	—
	1877-81	22,060,000	18,828,000*	40,888,000	4,215,000*
	1882-86	20,540,000	22,868,000*	43,408.000	5,772,000*
	1887-91	23,409,000	31,460,000*	54,869,000	8,781,000*
1891†		25,060,000	37,120,000*	62,180,000	14,066,000*

* These are coining values at the United States ratio of 16 to 1 of gold, that is about 59d. per standard ounce of silver. The commercial values of the silver production per annum are £16,747,000, £19,135,000, £23,860,000, and £28,365,000, respectively.

† The figures for 1891 are repeated by themselves, to show the latest returns, particularly as regards the purchases of the United States.

The next question to be considered is the production of gold and silver, and Table IV. gives an abstract of the figures from 1846 till 1891.

The above figures from 1846 to 1876, are those of Sir Hector Hay, and those from 1877 to 1891 are from the report of the Director of the United States Mint.

As this country is on the gold standard, and as we have no gold mines of our own, the following Table will show the movements of gold since 1858, when the official statistics of gold first began to be recorded :—

TABLE V.

UNITED KINGDOM.—GOLD.

Periods of Five Years.	Total Net Imports.	Total Net Exports.	Average per annum.
	£	£	£
1858-62	16,203,057	—	
1863-67	32,131,547	—	4,100,363
1868-72	18,159,364	—	
1873-77	15,513,292	—	
1878-82	—	3,864,277	402,368
1883-87	—	159,401	
1888-92	26,310,032	—	5,262,006

These figures are based on the details given in the Statistical Abstract, except for 1892, which is from the Board of Trade returns.

The average net import per annum in the twenty years, from 1858 to 1877, was £4,100,363, and in the ten years from 1878 till 1887, during which there was no balance of gold in our favour, the net export per annum was £402,368. There was thus a total deficiency of £45,000,000 of gold between 1878 and 1887, as compared with the average of the twenty years from 1858 to 1877. The five years, however, from 1888 till 1892, show a net import per annum of £5,262,006. It must be considered that, with the increased population of the later periods, it would have required a larger amount of gold to maintain the same level of prices as in the period from 1858 to 1867, whereas there has been an enormous decrease. Even if allowance is made for the economy in the use of money by the development of banking facilities, we should be entitled, from the above figures, to assume with perfect certainty that there must have been a considerable fall in the gold prices of commodities, not only in this country but wherever the gold standard prevailed. And it must be remembered that while we exported gold to the extent of £4,023,678, in the ten years from 1878 to 1887, the gold used in the arts during that period, estimated at £24,000,000, had to be withdrawn from the gold in circulation, so that we thus account for a positive withdrawal from the stock of gold in circulation in this country, amounting to £28,000,000, whereas we ought to have had the £28,000,000 and £17,000,000 in addition for new coinage. The reason why it was impossible we could have obtained the same supply of gold was that Germany, Sweden and Norway, Holland, the United States, and Italy all changed from silver or paper money to gold, and they made a new demand for gold amounting to about £225,000,000, without any new or increased supplies of the metal in the world, and, indeed, in the face of a falling off in its annual production. Thus, the countries formerly on the gold standard could get none of the annual supply from the mines, and had to submit to a serious contraction of their gold currencies.

Sir Robert Peel's celebrated question was, what is a pound? and to that question he replied that it was "a quantity of the precious metals, of certain weight and certain fineness." He did not say it was gold, though he afterwards recommended gold. It is commonly assumed that a pound or a sovereign is a standard of value, when in reality it is only a piece of coined gold of certified weight and fineness. So far from having a permanent uniform purchasing power, what the prices of commodities show is that a sovereign will purchase 50 per cent. more than it did 25 years years ago. It is, however, in common use as a measure of value, though an examination of the prices of the last 30 years would show how fluctuating its purchasing power has been, namely, in the proportion of 3787 in 1864 to 2120 in 1893, according to the *Economist's* figures. On account of these fluctuations, and the extremely low point to which the range of average prices of commodities has now fallen, the important question to which attention has for the last 16 years been directed, is the instability of gold as a standard of value.

In the "Monetary Question of 1892," by Mr. Ottomar Haupt, there are some very important statistics in regard to the supply of money in the world. Mr. Haupt is one of the highest living authorities on monetary statistics, and we gladly avail ourselves of his labours to illustrate our subject. He has made calculations for the end of 1885 and for the end of 1891, of the money in the following countries,

namely, Austria, Belgium, England, France, Germany, Holland, Italy, Portugal, Russia, Scandinavia, Spain, Turkey, other European countries, United States, and Australia. Deducting from the total amount given by him, the amounts apportioned to Austria and Russia, as neither of these had the gold standard, though they had large quantities of both gold and silver, we arrive at the following figures :—

Table VI.

Money in the Gold Standard Countries.

	End of 1885.	End of 1891.
Gold	£608,000,000	£644,000,000
Silver	263,000,000	320,000,000
Silver fractional currency	98,000,000	91,000,000
Uncovered paper money...	205,000,000	240,000,000
	£1,174,000,000	£1,295,000,000

There are a few countries left out, regarding which it is difficult to arrive at precise figures; but, nevertheless, the above may be taken as a close approximation to the amount of money in the world's currencies that were on the gold standard at the end of 1885 and of 1891. The answer, then, that we make to the question, "What is a pound?" is that it is £1 sterling in £1,295,000,000 sterling, all circulating the same as if they were entirely gold, and carrying on the monetary business named above. These countries, being on the gold standard, have all the same relative prices. But, when the above figures are examined, it is seen that, at the end of 1891, the actual gold entering into the money of the gold standard countries was less than one-half of the whole of the money in these countries. To that extent, therefore, the term gold standard is a misnomer, because it is really a standard of gold, silver, and paper money. It might perhaps be thought that the £644,000,000 of gold determined the value of the silver, the fractional currency, and the uncovered paper money, nd that these followed the value of gold without themselves affecting the value of gold. But it is not so; the £644,000,000 of gold is the supply of gold that went to determine its purchasing power as part of £1,295,000,000, all valued as gold. The annual supply of gold from the mines, if taken at £25,000,000, is a mere fraction of the stock at any time, and so it has very little effect upon the purchasing power of gold, particularly as about one-half of it is absorbed in the arts, and only about £12,500,000 can be available for new coinage, and for keeping up the wear and tear of the coinage; so that only this latter amount can have any effect upon prices, that is, less than 1 per cent. of the gold standard of £1,295,000,000. Then it must be remembered that the populations in the gold countries are increasing, and thus requiring more money; while, since the beginning of 1892, Austria-Hungary has entered upon the gold standard; and it will require to accumulate about £20,000,000 of new gold, that is, nearly two years of the total gold supply available for coinage, leaving no new gold for coinage in the other gold standard countries during that time.

The reason why the term gold standard is used in these circumstances is because gold alone in these countries has the privilege of being coined for private holders. The silver, the fractional currency, and the uncovered paper money exist by regulation of the Governments. The latter are bound to coin all the gold that may be offered for that purpose, and so the term gold standard is applied to the money in these countries. It is evident, however, that if the money of these countries was confined to gold, its purchasing power would be enormously greater than at present, and the prices of commodities which were at 100 in the period from 1865 to 1869, as in the table calculated from the *Economist's* figures, and at 69 in 1892, would be at 30, or thereabouts, and wheat, instead of being at 26s., would be at, probably, 12s. per quarter. The addition, however, of £650,000,000 of money that is not gold, but yet passes as if it were gold, to the £644,000,000 of actual gold, makes it possible that wheat should be at 26s. instead of 12s., and the *Economist* index number for the 22 commodities at £68, instead of at £30. This addition reduces the purchasing power of gold by more than one-half, that is, causes the gold prices of commodities to stand at more than double what they would be if the money consisted solely of gold. But to bring wheat back to 45s., and the prices of the *Economist* from £68, in 1893, to £100, which was the average of the years from 1865 to 1869, would require an addition to the money at present in gold standard countries of about £400,000,000. It is certain that we cannot hope to get additional supplies of gold to bring this about, and so, if any material improvement in general prices is to take place, it can only be by additions of silver or of uncovered notes.

Already, silver forms part of the gold standard to the value of £320,000,000 in dollars, 5 franc pieces, &c., and £91,000,000 in small change; and in order to find silver enough to add to the gold standard, so as to restore the prices of the period from 1865 to 1869, it would require more than all the silver of India, China, Japan, the Straits, and Mexico, that is, the whole of the silver of the silver standard countries, to be added to the money of the gold standard countries. It is an utter impossibility that the prices of a quarter of a century ago can be restored again, there is not metallic money in the world to restore them; and it can be asserted, with perfect safety, that there never will be sufficient of the precious metals to provide for the increased, and still increasing, populations in the gold standard countries, and to raise prices to anything like their former level. The known facts relating to the gold and silver mining industry lead us to expect that, for a time, the production of both metals may be increased, but they give no encouragement whatever to the idea that their production will be enormously or permanently increased; and, without an enormous increase in their united production, and the more extended use of silver in the currencies of the present gold standard countries, there can be no return to former prices. It is beyond the bounds of reasonable expectation that £400,000,000 of new money can be added to the gold standard from the gold and silver mines, in addition to the present supply, and, therefore, a return to the prices from 1865 to 1869 is physically impossible.

If we consider certain broad facts in relation to the demand for and the supply of gold, it will be evident that the fall in prices is due to the deficiency of gold in the gold standard countries. The following countries that were, in 1885 and 1891, on the gold standard, were, in the period from 1865 to 1869, on a silver standard or a paper money standard, namely, Germany, Holland, Italy, Scandinavia, and the United States. At the end of 1885, according to Mr. Haupt's figures, the amount of gold in these countries, which had all adopted the gold standard since 1871, was £254,000,000; and, if we deduct £44,000,000, as probably representing the amount of gold in these countries before they changed to the gold standard, we have then £210,000,000 of gold, which, if these countries had continued on the money systems they had previous to 1871, would have flowed into Great Britain, France, Belgium, Portugal, Spain, Turkey, and the British Colonies. These latter countries had, at the end of 1885, about £354,000,000 of gold amongst them; but, if they had had also the £210,000,000 of new gold at that time held by the countries which changed to the gold standard after 1871, their total holdings of gold would have been £564,000,000. At the end of 1891, Germany, and the other countries which have joined the gold standard since 1871, held £250,000,000 of new gold; while the above-named countries — Great Britain, France, &c. — had £350,000,000; whereas, if the £250,000,000 had flowed into the latter countries, they would have had £600,000,000 of gold.

The following Table will show the distribution of the stock of gold:—

Table VII.

Countries on the gold standard before 1871.	End of 1885.	End of 1891.
Stock of gold	£354,000,000	£350,000,000
Countries which adopted the gold standard since 1871.		
Gold before joining the gold standard	44,000,000	44,000,000
Gold added since joining the gold standard	210,000,000	250,000,000
	£254,000,000	£294,000,000
Total gold in gold standard countries	£608,000,000	£644,000,000

It is evident, therefore, that while the annual supply of gold had fallen off considerably, though it is now increasing, the countries on the gold standard before 1871 might have maintained a range of prices not much lower than those ruling from 1865 to 1869, if the distribution of the annual supply of gold had continued the same as before 1871. But the above Table shows that out of £644,000,000 of gold in the gold countries, £250,000,000 have been appropriated by countries which, before 1871, were not on the gold standard, and thus the countries which were on the gold standard had, at the end of 1891, only £350,000,000 of gold, instead of £600,000,000. It is needless to argue that there is no very great falling off in the annual supply of gold, when the countries that formerly received the most of it receive now less than three-fifths of it.

In considering the increased demand for gold, the amount in Government treasuries and banks ought to be taken into account. Professor Soetbeer has made an elaborate investigation into this subject, beginning with 1877, when he found the amount to be £144,000,000, and at his last date, in 1885, it was £252,000,000. Mr. Haupt's calculations since that time give the amount for 1886 at £227,000,000, and at the beginning of 1892 at £312,000,000. We know that within the last two years there has been an increase of the gold reserve in the banks in this country. This additional amount since 1877, that is, £168,000,000, has, therefore, been withdrawn from the active circulation, and there is so much less money acting upon the prices of commodities. This is equivalent to a contraction of the currency.

The statistics of our gold coins in circulation are very imperfect, but it may be of interest to bring together a series of estimates, made at different times by various authorities :—

TABLE VIII.

ESTIMATES OF STOCK OF GOLD COINS IN THE UNITED KINGDOM.

	Date.	Total amount.	Per Head of Population.		
		£	£	s.	d.
Newmarch	1844	46,000,000	1	13	5
Newmarch	1856	72,500,000†	2	11	9
*Miller.........	1858	90,000,000	3	3	5
Jevons	1868	80,000,000	2	12	8
*May	1872	107,637,000	3	7	7
*Gray	1876	122,368,000	3	13	11
Palgrave	1883	100,000,000	2	16	2
Childers	1884	95,000,000	2	12	10
Haupt	1885	100,000,000	2	15	6
Goschen	1889	73,000,000	1	19	3
Martin & Palgrave	1890	69,000,000‡	1	16	10
Fremantle	1890	105,000,000	2	16	0
Haupt	1891	105,000,000	2	15	1

* Officials of the Bank of England.
† £70,000,000 to £75,000,000.
‡ Their calculation is that the maximum amount will not exceed £75,000,000.

It must be borne in mind that the above figures do not include the bullion or foreign coin at the Bank of England.

It will be seen that the Bank of England estimate for 1872 was £107,637,000, and for 1876, £122,386,000. The bullion and foreign coin, not included in the above, will vary in amount, but it will probably be from £10,000,000 to £15,000,000. Following the estimate of Mr. May in 1872, and of Mr. Gray in 1876, Mr. Palgrave's estimate at £100,000,000 in 1883, Mr. Childers's at £95,000,000 in 1884, Mr. Goschen's at £73,000,000 in 1889, and Messrs. Martin and Palgrave's at £69,000,000 in 1890—with a qualification that it cannot exceed £75,000,000—all seem, looking to the movements of gold, to be approximately on the same general basis. I am strongly of opinion that these estimates are nearer the truth than that of Sir Charles Fremantle at £105,000,000 in 1890, and those of Mr. Haupt in 1885 and 1891 at £100,000,000 and £105,000,000 respectively, all of which I regard as too high.

TABLE IX.

INDIA.

Five Years ended March 31.	Average Gold Value of the Rupee.		Average Net Imports of Gold per Annum.	Average Net Imports of Silver per Annum.	
	s.	d.	Rx.	Rx.	
1860—64...	1	11·85	5,889,538	10,181,781	7,920,388*
1865—69...	1	11·43	5,835,117	9,981,112	
1870—74...	1	10·80	3,073,776	3,598,271	
1875—79...	1	8·975	639,595	6,408,692	6,503,575*
1880—84...	1	7·775	4,128,613	6,205,349	
1885—89...	1	6·287	3,083,670	6,896,685	
1890.........	1	4·566	4,615,304	10,937,876	11,378,399†
1891.........	1	6·089	5,636,172	14,175,136	
1892.........	1	4·733	2,413,792	9,022,184	

* Yearly average of 15 years. † Average ef 3 years only.

Coinage of Silver.

	Total coinage per annum.	Re-coined Rupees per annum.	Bullion, &c., *i.e.*, New Coinage per annum.	
	Rx.	Rx.	Rx.	
1860—64...	8,733,995	152,486	8,581,509	6,583,326*
1865—69...	7,900,929	151,211	7,749,718	
1870—74...	3,446,617	27,865	3,418,752	
1875—79...	7,421,864	51,072	7,370,792	6,530,584*
1880—84...	5,372,955	469,890	4,903,065	
1885—89...	7,759,403	441,509	7,317,894	
1890.........	8,551,158	619,042	7,932,116	8,781,455†
1891.........	13,163,474	305,195	12,858,279	
1892.........	5,553,970	—	—	

* Yearly average of 15 years.
† As the separate figures for bullion coined in 1892 are not yet obtainable, the total amount of coinage has been taken for this average, so the actual figures will be rather less.

As India is a typical silver standard country, the statistics in Table IX., in regard to silver in particular, and also to gold, will throw some light on the quantities of silver that were imported into India, and those that were coined, and the imports of gold and the relation of silver to its valuation in gold.

The five columns of net imports and coinage are the official figures of the India Office.

It will be seen from the above Tables that, during the five years from 1870 to 1874, the average net imports of silver per annum were only Rx.3,598,271, and the new coinage from bullion was only Rx.3,418,752, a great deal less than at any other period of the 33 years under review, yet it was in September, 1873, that the French Government began to postpone the dates for the payment of the "bons de monnaie" issued at the Mint in exchange for silver tendered for coinage. Notwithstanding this check on the flow of silver in France, and the delay in payment which was increased until the final suspension of coinage for private individuals in 1876, it will be seen that this abnormally low coinage in India, from 1870 to 1874, was not followed by any abnormally high coinage during the next fifteen years, as the average per annum was only Rx. 6,530,584. It is true that the steps taken to interfere with the previous free conditions of the coinage of silver in France, in September, 1873, warned Prince Bismarck that France was unwilling to take into its circulation the silver that Germany wished to get rid of, and this caused him to retain a large amount of silver which it was his intention to sell but for this closing of the French mint. As, however, India had an open mint during the whole period, and was bound to coin all the silver offered, it must be evident that if there had been increased quantities of silver pressing on the world's markets, and causing that metal to become depreciated, they must have flowed to the open mints of India. Yet we see that nothing of the kind took place, and that, in presence of increased populations in India, the coinage of rupees from bullion rather declined in amount in the 15 years from 1875 to 1889 as compared with the 15 years from 1860 to 1874. We might therefore expect that, with increasing population and greater development by railway and other agencies in India, it would have required an increased amount of coinage to maintain the former level of prices, and thus as no such increased coinage of silver took place, we should expect silver to become somewhat appreciated and silver prices to fall, and the Indian officials testify that prices did fall. We have already shown that English prices of commodities, valued in silver, fell until 1886 when they rose to par, but they declined again, though in 1892 they rose, and are now above par. It will further be observed that the coinage from bullion in 1891 rose to Rx.12,858,279, but then that was followed in 1892 by a total coinage of only Rx. 5,553,970. Silver has, however, now for the first time become somewhat depreciated. The years of course end at March 31st.

To sum up the leading facts in regard to gold, there is the undisputed evidence of statistics to demonstrate that the gold prices of commodities have fallen from 30 to 33 per per cent. since the period from 1865 to 1869, that is, gold has increased in purchasing power from 43 to 50 per cent. We have shown that the supply of gold from the mines had fallen off as compared with the period from 1852 to 1861, though the supply is now increasing; that for the ten years, 1878 to 1887, this country did not receive on balance any gold at all, but exported £4,023,678, and thus had a deficient supply in that period of £45,000,000; that since 1871 a number of countries with large populations, which before that time did not possess the gold standard, had adopted it, and at the beginning of 1892 they had £44,000,000 of old gold, and £250,000,000 of new gold, without any additional supplies having been obtained from the mines; that the countries on the gold standard before 1871 have therefore been deprived of £250,000,000 of gold since 1871, which they would have received had the monetary systems existing before 1871 continued from 1871 till 1891; that the populations in the countries on the gold standard before 1871 have gone on increasing, and to them have been added, in the demand for gold, both the populations of the countries which adopted the gold standard since 1871, and the increase thereto since that time; that there has been a large increase in the use of gold in the arts in the last twenty years; that the amount of gold, namely £168,000,000, which has been added since 1877 to the gold reserves of banks and Government treasuries, has thus proportionately diminished the amount available throughout the world for the maintenance of prices; and that our own gold coinage in circulation has been considerably reduced in the last sixteen years, while the population has considerably increased.

Against these important figures, proving the fall in prices and the falling off in the amount

of gold in the gold standard countries available for the maintenance of prices, the only consideration that can be adduced as tending to counteract the fall in prices is the greater economy in the use of gold in consequence of increased banking facilities, but this cause, though well entitled to consideration, was nevertheless in operation before 1871 as well as since.

While it would take too much space to enter into details regarding the practical effects of this appreciation of gold, it will suffice to give some indication of the enormous injury it has inflicted, if it is stated that the transfer of wealth from the landed and propertied classes, and from the mercantile, manufacturing, and producing classes generally in the United Kingdom, to the holders of securities, mortgages, annuities, &c., cannot be less than £2,000,000,000, due solely to the appreciation of gold. It is already a question how much further the holders of securities are to receive the assistance of a continually contracting currency to enable them to go on absorbing further and further the wealth of the producing classes. If no other relief can be obtained, it may be necessary to fix a commodity standard instead of a money standard for long-dated payments, as has been recommended by the principal economists of the last hundred years. Such a colossal unearned increment as has accrued to the holders of securities valued in gold during the last twenty years, in Europe and the United States, amounting to not less than from £7,000,000,000 to £9,000,000,000, is entirely unparalleled in the history of the world, and all other public questions sink into utter insignificance compared with it.

On the other hand, silver in London, after having for the last 20 years increased in purchasing power to some extent, as compared with the period from 1865 to 1869, thus showing that it had appreciated and not depreciated, has now returned to a lower level of purchasing power, that is, a higher level of prices, than 25 years ago. The net imports of silver into India and the coinage of new silver have continued so steady that they give no support to the theory that silver has depreciated in regard to commodities, except to a small extent since 1892. There is now, therefore, a divergence between the purchasing power of silver and that of gold to the extent of more than 50 per cent. as compared with the ratio between the two metals up to 1873, that is formerly £100 in gold would purchase a certain amount of silver, now £100 will purchase more than 50 per cent. in addition.

The amount of silver money in India, China, Japan, the Straits, and Mexico may be estimated to be about £390,000,000, while the silver money in the gold standard countries has already been stated at £320,000,000 for dollars, five franc pieces and other full legal tender money, and £91,000,000 for silver small change, making in all £411,000,000. The amount of silver in the gold standard countries is thus larger than the amount in the silver standard countries. And yet, though the £644,000,000 of gold is assisted by £651,000,000 of silver and paper money, so as to make up the gold standard, we find that after a fall in prices of more than 30 per cent., the tendency is still downwards. This shows beyond a doubt that there is not enough money in the gold standard countries to maintain the range of prices, and the very serious question arises as to how much further prices will fall under the existing system in the gold standard countries. As the evil has been brought about by deficiency in the supply of money, the steady fall in prices can only be arrested by some increase in the volume of money, and the only means of increasing the volume of money that has been recommended is by the gold standard countries of Europe adding more silver to the present circulation. There is no other practical proposal at present formulated, and this was the object that brought the Brussels Conference together, namely, to increase the use of silver in the gold standard countries, so as to arrest the fall in gold prices and in the gold price of silver and therefore of the rupee; and the Conference gave an almost unanimous support to the idea of the great importance of increasing the use of silver in the gold countries.

But besides the increased use of silver circulating as gold, there is another important point on which it can hardly be said that there is any division of opinion, and that is the fixing of a par of exchange between the silver countries and the gold countries, so as to put an end to the fluctuations between gold and silver. This is, without doubt, a very difficult question, because any ratio between the metals near the present ratio, will fix permanently on India and the other silver countries the present greatly increased burden in silver of their gold obligations, by fixing a permanently low gold price for the rupee; while a ratio that will relieve India of its unjust burden by materially raising the gold price of the rupee, will cause a fall in Indian prices of commodities. Still, the danger of a

further fall in the gold price of the rupee, owing to the further appreciation of gold and the depreciation of silver which began, to a slight extent, in 1892, and which we may expect to continue if the United States should suspend the purchase of silver, is so great that the position of the Indian Government is very perplexing. If the European gold countries were to purchase a substantial amount of silver annually, and put it into circulation, that would be a benefit both to Europe and to India and the other silver countries. It would arrest the fall of gold prices and of the gold value of the rupee, and give time to Europe to see the effect of its increased use of silver. It is evident that the present difficulty is one exclusively arising from the deficiency of gold, or money passing as gold; and so long as the United States continue to coin silver at the present rate, there will not be any serious difficulty in the internal trade of the silver standard countries, except in regard to obligations to be paid in gold. The following figures may be taken as a rough estimate of the amount of silver money in the silver countries:—

Table X.

Silver Money in Silver Standard Countries in 1892.

India	£180,000,000
China	150,000,000
Japan	20,000,000
Straits	24,000,000
Mexico	16,000,000
	£390,000,000

This is the valuation in gold, and in comparison with it the total amount of gold, silver, and paper money in the gold standard countries is £1,295,000,000. The currency problem, therefore, presents itself in four district questions, namely (1), how is the money in the gold standard countries to be increased; (2), how are the silver standard countries to be protected againt the demonetisation of silver in the United States and in Europe, as well as from the probable increase of silver from the mines; (3), how is a fixed par of exchange to be established between gold and silver, that is between the £1,295,000,000 of money in the gold standard countries, and the £390,000,000 of money in the silver standard countries; and (4) what should be the ratio between gold and silver for the fixed par of exchange. It has already been pointed out that it would require £400,000,000 of money, that is more than all the money in the silver standard countries, to be added to the £1,295,000,000 in the gold standard countries, if the object were to restore the range of the gold prices of commodities that existed in the period from 1865 to 1869. That will give a broad and general idea, without pretending to exactness, as to our position in regard to gold prices in 1865 to 1869, and our position in regard to gold prices at the present time.

But the gold countries and the silver countries can only deal with what they have, and so whatever par of exchange might be fixed between gold and silver, it is impossible for the gold standard countries ever again to reach the range of prices of the period from 1865 to 1869. There is not gold and silver enough produced at present to restore the former range of prices, and there is practically no hope that sufficient gold and silver will ever be produced. The populations of the world on the gold standard are increasing so rapidly, that they have entirely outrun the world's supply of gold, and even with the assistance of £411,000,000 of silver money, and £240,000,000 of uncovered paper money, that is of paper money in circulation against which no specie is held, the fall in prices continues at an alarming rate. It is further to be observed, as shown in the Table IV. of the world's production of gold and silver, that of the £37,120,000 of silver in 1891, as estimated at the coining value in the United States of 16 to 1 of gold, the United States are now purchasing £14,000,000, and adding it to the £25,000,000 of gold, and thus making the supply of gold £39,000,000, and the supply of silver only £23,000,000, and yet the range of gold prices in September last was, according to Mr. Sauerbeck, the lowest of the century.

If the United States were to abandon their purchases of silver, the effect would be to withdraw £14,000,000 of money per annum from the gold standard countries, and to make a large addition to the money of the silver standard countries. This would be an injury to the gold countries by withholding part of the present insufficient supply of money, and it would be an injury to the silver countries by throwing upon them additional silver that they do not require, for the purpose of maintaining their present range of prices. Any policy of the kind would materially widen still further the divergence between silver and gold, and be an enormous injustice to the small number of silver money countries. The proposal of

Mr. Alfred de Rothschild, at the Brussels Conference, is therefore based upon the fact that the monetary difficulties are exclusively in connection with the gold standard, though silver is menaced by the possible action of the United States, and he proposes that the direction in which a remedy should be sought is in the coinage of a considerable amount of silver annually by the gold countries of Europe in conjunction with the United States, which at present is the only gold standard country that is trying, by coining a large amount of silver, to increase the total amount of money in the gold standard countries, and thus arrest the fall in gold prices. It is evident that as the monetary difficulty is caused by contraction of the gold currency, the remedy can only be found in some policy that will arrest this contraction, and thus arrest the fall of gold prices. As there has been no recommendation of increased issues of paper money, the only way in which the money of the gold standard countries can be increased is by the addition of silver.

Now, as a matter of fact, with £1,295,000,000 of money in the gold standard countries, and £390,000,000 of silver in the silver standard countries, it would be impossible to raise gold prices to any high point, under any ratio between silver and gold that has ever been proposed. It is safe to say that, even if the French ratio of 1 to 15½ could be restored at once, gold prices of commodities would not rise more than 10 per cent., though the gold price of silver would rise from 1s. 3d. to 1s. 11d., or thereabouts, and Indian prices would undergo a considerable though not a corresponding fall. But it is very doubtful whether the ratio even of 1 to 15½ would, if it was arrived at by degrees over the next ten years, do more than maintain the present level of the prices of commodities, and it might fail to maintain even the present level. Austria is coming on to the gold standard, Chili is following the same policy, and Russia may do so in the near future. If the United States were to suspend the coinage of silver dollars, and Europe were to refuse to add full legal tender silver to the gold standard, that is, in addition to the fractional silver currency that all gold countries coin, it is quite certain, notwithstanding some increase in the annual supply of gold, that the present level of the gold prices of commodities could not be maintained, at least for any length of time. Therefore it is imperative that more silver should be added to the gold standard in Europe, so as to arrest the fall in gold prices, and there need be no fear of adding silver, because if even the maximum quantity were added, the rise in prices would be very limited, though it would impart some new life to the depressed trade and industry of the country. Mr. de Rothschild's proposal for the European gold standard countries to purchase, say, £5,000,000 of silver annually for five years, at a price not to exceed 43d. per ounce, will, if the United States continue their present coinage of silver, arrest the fall in the gold value of the rupee, because the purchase will affect silver, though it is doubtful if it will have much effect on the gold prices of commodities, as the amount added to £1,295,000,000 will be so small; but for the time it will be a benefit, as well as an experience, which is much wanted in this country. The quantity of silver to be purchased is, however, too small, though this is at least a step in the right direction.

The objection to it is, that it is a policy which is not based on any principle, though in an imperfect manner it aims at the object in view, namely, of adding silver to the money of the gold countries, and of keeping back unnecessary additions to the money of the silver countries; but it fixes an annual sum, irrespectively of the amount of silver that may be produced, and it does not lead to any fixed par of exchange between silver and gold. As, however, the fact that Mr. de Rothschild put forward this proposal, coupled with a recommendation to raise our legal tender of silver from £2 to £5, it is to be presumed that our Government, which alone in Europe has opposed all monetary reform in the last 16 years, is willing to take part in the carrying out of such a policy; and if so, that is in all probability the most that can be obtained at present. This country would raise the limit of tender of silver to £5, without any change in our coins, but the other countries would, we presume, add to their full legal tender silver, and not merely to their small change. It is hardly necessary to point out that if the United States and France were to demonetise their dollars and 5 franc pieces, amounting to nearly £240,000,000, there would be a further contraction of the money of the gold standard to an extent that could not fail to bring additional disaster on Europe and the United States. Even if they were only to re-coin their silver at something near the present ratio, it would be a serious contraction of the gold currencies, as the £240,000,000 would then be re-coined into about £160,000,000, by

this act striking out of existence £80,000,000 of the present money in the gold countries. Any avoidable diminution of the quantity of money in the gold countries ought, in the strongest manner, to be deprecated, as the civilised world is interested in the full legal tender silver coins in the gold countries remaining as they are, and not being re-coined into heavier weights and fewer pieces, that is a less amount of money.

It is a most difficult problem to reconcile, under any proposal, the interests of India with those of the gold standard countries. There is no solution possible that will favour both, and bring with it no drawbacks. The only solution that would not in any way be a drawback to India would be the addition of about £400,000,000 of new money in the gold standard countries, as this would restore the purchasing power of gold to the *status quo* of 1865 to 1869, and the purchasing power of the rupee is just about the same as it was during that period. But this is impossible. To landowners, farmers, owners of house property, merchants, manufacturers, and producers generally, the fall in the gold valuation is in great measure irrevocable, there can be no possible approach to the prices of twenty years ago, and there is reason to fear that there may be a further fall in gold prices of land and commodities. Mr. de Rothschild's proposal is before us, it has presumably the approval of the Government, it was received favourably at the Monetary Conference, it is a step in the right direction, and as there is no other proposal equally available, it would be well if it were accepted and acted on without delay. Mr. de Foville's proposal of silver warrants stands on a very different footing, as the value of the warrants, if I understand the proposal rightly, would fluctuate with the value of silver, and thus remain merely a commodity with a fluctuating gold value. Mr. de Rothschild's proposal, on the other hand, would, as I understand it, add the silver to be purchased to the existing silver money of full legal tender in the gold money countries, except in the case of this country, which would add to its existing silver coins, and this new silver would be coined into a definite amount of money, and would pass as gold, like the existing full legal tender silver coins.

If, however, our monetary policy is to be based upon a permanent and automatic principle, bimetallism must be adopted, and it is certain that, if Mr. de Rothschild's proposal is accepted and acted upon, the experience that will be gained will lead to bimetallism. It will be a matter for arrangement between the Governments as to the ratio to be adopted, but whatever ratio is decided upon will establish a fixed par of exchange between silver and gold, between the silver countries and the gold countries; and all the countries using the precious metals as money will thus have the same relative prices of commodities, and the same purchasing power in their money. The bimetallic system is getting better understood, and we cannot doubt that it will ultimately prevail. The adoption of it would render unnecessary in India any gold currency or gold standard without gold. If, however, a gold standard should be decided on for India, without bimetallism, then, for reasons that I gave 12 years ago, in the *Westminster Review*,* I prefer a gold standard without gold. In considering the question of the regulation of the Indian currency, and Mr. Lindsay's proposal to make the Bank of England responsible for it, there are various weighty objections to any system that withdraws from the Government in India the complete regulation of the currency. If the coinage of silver is to be limited or suspended, so as to arrest the fall in the gold value of the rupee, or to raise it to a higher gold value, the duty and responsibility of carrying out this policy ought to devolve upon the Indian Government on the spot. It would, however, be very much better for India if bimetallism were adopted rather than any limitation or suspension of coinage that would sever it from the other silver standard countries that lie so near it, by a divergence between the rupee and the silver money of the Straits, China, and Japan. But if India decided to cut adrift from the other silver countries, total suspension of coinage might be too drastic a measure, and it might be found more prudent to purchase and coin a fixed amount of silver per annum, larger or smaller in proportion as the object might be to arrest the further fall of the gold value of the rupee, or to raise its gold value—a question for the Indian Government and people.

But it may be well to point out an important distinction between the action of bimetallism and the action of the suspension or limitation of the coinage in India. Under bimetallism the gold value of the rupee could be raised to any figure, say, for example, to 1s. 11d., but

* October, 1880, article "East Indian Currency and Exchange."

Indian prices would not fall proportionately, as 1s. 11d., is to 1s. 3d. or 23 to 15. The reason is that under bimetallism, while the rupee went to 1s. 11d., gold prices of commodities would rise and silver prices would fall until they came to a meeting point. Gold prices would probably rise about 10 per cent., while silver prices would fall about 20 to 25 per cent. But if under suspension of the coinage the rupee was put up to 1s. 11d., Indian silver prices would fall 30 to 35 per cent., for the simple reason that gold prices would remain entirely unaffected, and thus silver prices would require to fall just as far as the rupee rose. If under the suspension of coinage the rupee is raised to 1s. 8d., or 1s. 8½d., Indian silver prices would fall as far as they would do under bimetallism, with the rupee raised to 1s. 11d. This is one of the extremely important advantages that India would gain by bimetallism as compared with suspension of the coinage, and if the other advantages of bimetallism are considered, its importance to India at whatever ratio may be agreed upon is overwhelming.

The progress that bimetallism has made in the last ten years must be regarded as very satisfactory. Sir Louis Mallet, one of the delegates at the Paris Monetary Conference of 1881, at which the United States and the fourteen leading countries of Europe were represented, has recorded his opinion "that, on the occasion of the Monetary Conference of 1881 at Paris, it appeared probable that, if the assent of her Majesty's Government could have been obtained, such an arrangement as I have suggested [namely, bimetallism] would have been acceptable to the other Powers." So that, at that Conference, bimetallism was so thoroughly understood and accepted, that Sir Louis Mallet regarded all the other representatives, except those of our own Government, as prepared to accept on behalf of their Governments a proposal for bimetallism. Then our own Gold and Silver Commission of 1886 to 1888 found unanimously that bimetallism had, in the 200 years ended in 1873, preserved the ratio between silver and gold, so that it did not vary more than 3 per cent. above or 3 per cent. below the fixed ratio of 1 to 15½. The six monometallist Commissioners favoured bimetallism for every country except our own, and recommended that, to facilitate this object, the Bank of England should hold one-fifth of its specie in silver, as permitted by the Bank Charter Act of 1844. Sir John Lubbock and Mr. Birch, however, appended a note expressing a doubt whether the ratio could be permanently maintained. In the late Conference at Brussels, bimetallism was advocated by all the American representatives and by M. Tirard, now French Minister of Finance, and many of the European representatives. Last October Mr. A. J. Balfour, M.P., made a special speech at Manchester in favour of bimetallism ; and Mr. Henry Chaplin, M.P., advocated its adoption at the Agricultural Conference in London in December, and thus we find it increasingly understood and increasingly accepted. It is true that there are some violent opponents of the principle who would wish us to believe that the system never was, and never could be successful, and that the leading Governments and leading statesmen of the age are supporting a foolish proposal. Indeed, during the last year a volume was published by Dr. Giffen, entitled "The Case against Bimetallism," in which the crowning demonstration in favour of his views consists in ten pages of monthly quotations, from 1820 to 1847, of the premium on gold in Paris. The contention in the volume is that as gold was at a premium for purposes of export, the French standard was one of silver, and not of the two metals. Dr. Giffen speaks of "the transition from one standard to the other occurring at a flash." But this scheme of bimetallism being an alternating standard, and of the change from the one to the other at a flash is purely imaginary, and indeed is a complete misconception of the operation of bimetallism in France.

Table XI., p. 231, shows the annual amount of gold and silver tendered at the French Mint, from 1806 till 1875, under the law of 1803, that is, during, practically, the modern bimetallic period.

Now this is the entire coinage of gold and silver from 1803 till 1875, and up till 1873, when interference with the system first began, the whole of this gold and of this silver was tendered at the French Mint on the ratio of 1 ounce of gold to 15½ ounces of silver. There was not a single year during the whole period in which silver was not tendered and coined, and gold was coined in every year except 1872 and 1873. It will be seen that on the resumption of specie payments by this country in 1821, the coinage of gold in France fell off in a very marked degree, and on the influx of gold from 1851 the coinage of silver fell off. So that the whole of the gold and silver coined in France from 1803 to 1875, amounting to the enormous sum of £322,993,410 of

TABLE XI.
GOLD AND SILVER COINED IN FRANCE CONVERTED AT £1 PER 25 FRANCS.

Period of Five Years.	Gold average per Annum.	Silver average per Annum.
1806—10	£1,201,136	£1,884,737
1811—15	3,299,503	5,208,029
1816—20	1,951,604	993,111
1821—25	465,748	3,526,432
1826—30	293,976	5,032,004
1831—35	826,149	6,576,120
1836—40	589,857	3,048,189
1841—45	159,326	3,033,286
1846—50	1,294,337	4,311,276
1851—55	12,669,263	1,431,755
1856—60	21,605,465	666,651
1861—65	7,667,357	175,088
1866—70	9,546,561	3,402,020
1871—75	2,475,213	2,742,776
	Total Gold.	Total Silver.
1803—75	£322,993,410	£217,640,234

the former, and £217,640,234 of the latter, was tendered at the French Mint without premium and without discount for either metal, and it is certainly a complete vindication of the effectiveness of bimetallism that the French Mint should have received and coined in 73 years £540,633,644 of gold and silver at the value of 15½ to 1 for equal weights. Mr. Henry Hucks Gibbs, in a late pamphlet* clearly shows, amongst other interesting points, that the money price to be obtained for gold and silver at the French Mint was as exactly fixed for both metals, and continued so from 1803 to 1873, as the price of £3 17s. 9d. is for the ounce of gold at the Bank of England, and owners of silver in London, sending it to the French Mint, knew exactly what amount of English money they would receive for it at a given rate of exchange on Paris. Further, in the ordinary financial, banking, and commercial business of France, apart from the trade in bullion, coined money of gold or silver was never either at a premium or a discount, and this statement is not made without complete inquiry into the facts. Dr. Giffen imagines when gold or silver bullion or coin was at a premium for export, that in the banking and trading transactions of France a profit could be made by paying in the metal that was not at a premium for export. But the French people, apart from the bullion dealers, were totally unaffected by the premium for export, and in this whole period never knew anything of the alternating standard which Dr. Giffen and others have conjured up out of their imagination, or of debts being paid in either more or less than legal tender money, gold, silver, or paper, any more than the customer of a London Bank knows when he sees in the papers that there is a premium on gold in London. He has no knowledge of it whatever from his bank account, and neither had the customer of any French bank in the period under consideration.

* "The Fall in the Gold Price of Silver, and the Closing of the French Mint."

With most of the leading Governments and the leading Statesmen of Europe, the United States and India, perfectly convinced of the effectiveness of bimetallism, and willing to adopt it if all the principal countries will join in an international arrangement; with bimetallism as the sole remedy discovered by the Gold and Silver Commission, after sitting for two years, in which they failed to find any defence for monometallism as it has operated during the last 19 years, it is not necessary to enter into any elaborate vindication of the bimetallic system. While Mr. de Rothschild's proposal, or something akin to it, will, for the present, give a breathing time in the divergence between gold and silver, it is nevertheless to bimetallism that we must come at last, if the nations of the world are to have equally, and without favour or prejudice, the benefit of all the gold and silver available for coinage; with a fixed par of exchange between silver and gold; and a single money standard, and the same relative prices in all countries using the precious metals as money. Without bimetallism, as we have seen during the last nineteen years, these advantages cannot be obtained, and therefore it is that we regard the final triumph of bimetallism as inevitable.

DISCUSSION.

Mr. J. M. MACLEAN said he greatly admired the courage of Mr. Barr Robertson, in giving so interesting and careful an essay on bimetallism immediately after the failure of the monetary conference at Brussels. That would have damped the spirits of any ordinary man, but bimetallists were notoriously sanguine. They had had a succession of Commissions and Conferences, and one feature about them all was that, while bimetallists in the closet or at meetings like that he was addressing, were always very ready to

show that bimetallism was the infallible remedy for all the ills which affected the commercial world, no sooner did they come together, than they were utterly unable to agree upon any practical method by which their scheme could be introduced. He had not expected that the paper would go so fully into the whole question of bimetallism, but rather that it would deal with the Indian aspect of the question. He thought Mr. Robertson entirely underrated the enormous strength of the forces arrayed against any attempt to interfere with the present currency system of England. He based his defence of bimetallism on a doctrine, which was entirely fallacious, maintaining that low prices were a real calamity for the people of this country. Now he (Mr. Maclean) submitted that low prices of commodities were emphatically the greatest boon that could be given to the great mass of the people who depended on weekly wages. Wages were not lowered, and they could buy every article they wanted at much lower prices than they could before. Even at the present moment, the returns showed an enormous consumption of dutiable articles by the masses of the people, proving that there was an immense amount of comfort and prosperity prevailing. The fallacy was to overlook the fact that the producer was also a consumer. He had argued this matter with the operatives in Lancashire, who were somewhat bitten with this bimetallic notion. They said they could get larger prices for their manufactures if money was more plentiful; but, he asked them, what would it benefit them, if prices were raised all round for cotton, food, clothing, coal, and everything they consumed? That was really the gist of the matter. There would be no gain to the great mass of the people from the introduction of this system of bimetallism. He wished to speak principally on the numerous proposals made to interfere with the currency of India, on which he had some right to speak, because, 10 years ago, he read a paper in that room on that very subject, when, in contradiction to the opinion then commonly received, he maintained that the depreciation in silver had not injured India in any way, but that her trade was increasing, and would continue to increase. The experience of the past 10 years had strongly confirmed him in that opinion. What was the real cause of the loss by exchange which was spoken of as falling upon India? It was due to the fact—a very important economic fact—which would have to be taken into serious consideration some day, that India was obliged to export £17,000,000 worth of produce, equal to about £25,000,000 in rupees at present prices, in order to pay the interest on her debt to England, and to pay dividends on the capital invested in railways, and to pay for all the other items of her home expenditure. He was rather amused when Mr. Barr Robertson spoke about contracts, and said the time was approaching when we should have to consider whether people who had contracts should not be paid in commodities. Would he apply that doctrine to holders of shares in Indian railways in this country, to guaranteed shareholders who had exceeded probably the Egyptian bondholders in the enormous amount of money they had taken from India as interest on their capital, all of which had to be paid in sterling? England never spared one penny of the money that had to be paid her, and year by year India had to go on remitting an increasing amount of rupees to pay the home debt. That was the cause of the loss by exchange that fell on India. A Commission was appointed, at the instance of the Government, to advise the Secretary of State whether he should not introduce some change into Indian currency, such as the adoption of a gold standard. He should think that, although that Commission was composed of very distinguished men, they would hesitate to advise a change in the currency system of India without going out to India and studying the working of the system on the spot, and seeing how advantageous it was to the trade of the country. Attention had been called to the fact that a large quantity of gold had been lately exported from India—a phenomenon of rare occurence. Why was that? Because the astute Indian money dealers knew an attempt was about to be made to raise the rupee to an artificial price, and, therefore, as they could buy 16 rupees for £1 they sent gold abroad to purchase silver, and directly any change in the rupee was announced they would come forward at once and demand gold, hoping to be able to buy a sovereign at the rate of 11 or 12 rupees. What would be the result if they introduced a gold standard without a gold currency? All the people would immediately demand gold for rupees, and if there were no gold what would be, not only the financial, but the political result? It would be not only disastrous economically, but might have the most serious effect in shaking the very foundation of our rule in that country. They were told very frequently that the Indian trade had been ruined by the fluctuations in exchange, that the financial position of the Government was becoming perfectly intolerable, and that in fact India was on the brink of insolvency. With regard to the trade, taking the figures from the statistical abstract, the imports had increased during the last ten years from £60,000,000 to over £94,000,000, or at the rate of more than 50 per cent.; whilst the exports had increased from £82,000,000 to £103,000,000; that is to say, by 25 per cent. The whole volume of trade, therefore, had increased; but the most significant feature in the returns was, that the imports had increased in a much larger proportion than the exports, so that India was getting a much larger quantity of goods from other countries in return for her exports than she used to. Again, he thought Mr. Barr Robertson had under-estimated the immense quantity of treasure in India, in stating it at £180,000,000 of silver. According to the official statistics, during the last 20 years, India must have added to her stocks of silver and gold something like £350,000,000—£230,000,000 of silver and £120,000,000 of gold. He fully sympathised

with the woes of some individual officials who suffered a loss on that portion of their incomes they had to remit to this country, and thought there should be a revision of contracts, so that they should have equitable compensation. But the national interests of India must be regarded, and from that point of view India had prospered immensely since the depreciation of silver began. With regard to the financial position of the Government of India, which was said to be very bad during the last ten years, instead of there being a deficit, there had been a net surplus of £7,500,000 sterling, or crores of rupees, and most of that had accrued during the last five years. In 1891-2, when it was thought there might be a deficit, according to the latest estimate there was a small surplus. The only difficulty was with regard to 1892-3, in which the remarkably large fall in the price of silver might cause a serious loss. But was that the only cause which affected the estimates? The elasticity of the Indian revenue was such that, in spite of the temporary fall in opium, the deficit caused by the loss on exchange would have been more than filled up had it not been for the very prodigal military expenditure. The losses by exchange had increased from £3,000,000 to about £6,000,000 during the ten years, but the military expenditure, which at the beginning of the period was about £15,000,000, was now nearly £21,000,000, or an increase of between £5,000,000 and £6,000,000. That was a far more serious thing for the Government than even the loss by exchange, and it arose very largely from the fact that the military element had for a long time been supreme in the Council of the Viceroy, and the civilian and commercial element had been powerless. All that the Finance Minister had been able to do was to make protests occasionally against the decisions of the military Government of India. That was not the place to discuss the policy of military expenditure upon a scientific frontier, but the expenditure on frontier expeditions and special defence works had amounted to something like £35,000,000 in the last ten years, and there were Royal Engineer officers in India who would never be satisfied until they had rendered impassable the whole line of the Hindoo Koosh, and fortified the whole frontier from the Pamirs to Herat. The best remedy for that sort of thing was to send out a practical man of business, and put him in charge of the finances, and to strengthen the commercial and civilian element in the Council. If there should be a deficit in the present year, why should not a loan be raised for the purpose of meeting it? Indian rupee paper stood at a very high figure, and no doubt it would be gladly taken up the natives. It would be only following the precedent set at home when a loan was raised for the fortifications of this country. That would have a beneficial effect in putting off the necessity for raising fresh taxation until the result of this discussion about silver had touched bottom, and they were face to face with the need for a settlement of the great practical difficulties.

Mr. HERBERT GIBBS said with respect to the question of cheapness, it was the excessive variability of our English standard that he objected to, and for that reason he wished a change. Mr. Maclean said cheapness was always good. The bimetallists that cheapness was always good if it arose from abundance of commodities, but that it was bad if it arose from a scarcity of the measure of value. If cheapness was good why was there such a period of prosperity after the gold discoveries in America and Australia? He might refer to Alison's dictum that the fall of the Roman Empire was due more to the falling off in the production of precious metals than to any other cause. Again, when reference was made to the working man, was not his labour a commodity. Were not wages raised when the country was prosperous, and did they not fall when the country was not prosperous. Mr. Maclean said the producer was also the consumer, but he seemed to forget that the consumer was also a producer. Were not the labouring classes all producers? If this country were prosperous would not they share in the prosperity? Their view was that if their masters profited they would share in it.

Sir GUILFORD MOLESWORTH, K.C.I.E., said he quite agreed with Mr. Maclean as to the inadvisability of introducing a gold standard for India; it would only result in our taking upon our shoulders there the same burden which pressed so heavily on England, Ireland, and the whole of Europe. If gold became further inflated, as there was reason to believe it would be, they would be taxing the natives indirectly to a much greater extent than if they were taxed directly. With regard to the late Conference, he went to it with little hope of any practical result, owing to the obstructive attitude of England; but, nevertheless, he came away, as he held most bimetallists did, satisfied that considerable indirect progress had been made. He did not expect any direct results, because he knew how impossible it was to break through the crust of stolid, uninquiring prejudice existing in England; but a great many valuable admissions had been made. There was the admission by Mr. De Rothschild that something must be done or there would be a fearful crisis, which was noteworthy, following on Mr. Goschen's warning as to the danger to which we were exposed. Then there was a general feeling expressed by almost every delegate except the British, that if England only withdrew her opposition the thing might be settled at once; and it was also admitted that all the palliatives brought forward were utterly useless, except as paving the way to the only practical solution, viz., a return to the double standard. There was a general wish expressed that the Conference should meet again, and that Mr. Rothschild's proposal, which was killed by English obstruction, should be revived. It was stated by the French delegate, M. Tirard, that if only England and Germany would come in there would be no

difficulty. The struggle is between Lombard-street and the industrial interests, owing to the fallacious idea that the banking interest was favoured by the present system; that as all obligations had to be settled in gold, people were induced to bring their business to England. But even admitting this idea to be correct, it was one thing to consider the interest of bankers, and another thing to consider the interest of their customers. It was no consolation to those who had to pay money to be obliged to do so in an appreciated, and appreciating, metal. Times of low prices, due to contraction of currency, were always times of depression and misery, of strikes, and Nihilistic agitation. It was no use having low prices which deprived men of employment. Mr. Alexander Baring, in 1819, remarked that an alteration in the value of currency was a fact which few even of the wisest perceived; and Alison also referred to it as the most important factor in social questions which was generally overlooked, and its effect attributed to other causes. Mr. Ernest Seyd, in 1871, predicted all the disasters that have since arisen from the demonetisation of silver; he also predicted that the gold doctrinairism of England would be so blind as to attribute the evils arising from changes in the value of the currency and trade depression to any other source but the right one, and that prediction had been strikingly fulfilled in every respect. The reason of the depression had been very clearly stated in the paper, viz., the appreciation of gold in consequence of half the money of the world having been suddenly demonetised; the result was necessarily an increased demand for gold, or, in other words, a fall in prices. The gold-demanding population of the world had been quadrupled, so that an appreciation of gold was the necessity and logical consequence; and yet people continued to attribute the effect to all sorts of irreconcileable causes. A great deal had been attributed to modern improvements, but that had been gradually going on for years. Prices rose immensely with the great flood of gold into Europe from California and Australia. There was a reaction after, but they were steadily rising before 1873, and the fall in prices set in exactly when the link was broken between gold and silver. Silver was just as much money to half the world as gold was to the other half, yet silver prices had remained unaffected, while gold prices fell. A fallacy underlies the cry of cheap food and low prices. The industrial classes do not reap the advantage of the fall of wholesale prices in any degree commensurate with the losses they sustain by depression, because a fall in wholesale prices, that may be sufficient to cause depression of trade or even to ruin an industry, may be insufficient to affect seriously retail prices. Moreover, retail prices do not as a rule follow the fluctuation of wholesale prices. Take for example a most important case in point. The price of wheat has fallen about 50 per cent. in the last twenty years, yet the price of bread is almost unaffected. The fall of wholesale prices in cotton, woollen, or silk industries, which threatens the reduction of wages, want of employment, if not the extinction of the industry, offers but little compensation to those thrown out of employment.

Mr. R. B. Chapman, C.S.I., said he envied his friend Mr. Maclean in being able to find anything amusing in this subject, and in being able to speak of any branch of it with anything approaching to levity. He held it to be the most grave and serious of all the many difficult problems with which England had now to deal. Home Rule was a difficulty, but it was nothing compared to this question of the standard. The views which he had adopted, after long experience, were so alarming, that nothing would gratify him more than to find that he was altogether mistaken. Mr. Maclean, speaking on behalf of a large number of influential people, scorned the idea of bimetallism; but the time would come when they would have to adopt it, and the only question was through how much tribulation they would have to pass before they were convinced. The evils which affected England were far more formidable than any which affected India, and he was positively alarmed at the indifference of English politicians, statesmen, and financiers. If men of the intelligence of Mr. Maclean could be so blind to what was happening under their eyes, what was to become of the country? They could all see what was happening to agriculture. Did monometallists pretend that the low prices which were ruining trade all round were a benefit, or that the low prices which made Argentina insolvent, and brought down the great house of Baring, and caused the tremendous depression now witnessed, and which had only begun, were a benefit? Low prices were very well if they were steady, but a price continually falling made all industry absolutely impossible. Mr. Robertson had not noticed the real crux of the question—it was not a question of a high standard or a low, of gold or silver—the vital point was to have a steady standard. Without that, a country must by degrees be throttled and strangled; one after another all debtors would become insolvent, and England would eventually become insolvent too. Mr. Maclean spoke of India repudiating her debts—

Mr. Maclean said he only adopted Mr. Barr Robertson's argument.

Mr. Chapman said if India ever did that, England would be disgraced in the eyes of the world. Her debts were not unreasonable in themselves; the money had been honestly borrowed; it had been, on the whole, well and usefully spent, and the interest paid was low. If India turned round, and spoke of that as a tribute, or as if England was exacting from India that which she had no right to claim, it would be as bad as if he called his baker a robber when he asked payment for his bread. But the time might come, and probably soon — if nothing was done — when

India would not be able to pay her debts. If any one could contemplate such a state of things with a light heart, he could not. The only thing to prevent that was bimetallism. The present appreciating standard was piling up the burden on all debtors, the weight was being added to every year, and it was only a question of time when every country that owed a gold debt, and every individual too, must become insolvent. The only other remedy would be that trade would be so utterly paralysed that there would be no longer any demand for gold, and the body politic would be a corpse. He must say that he differed from the reader of the paper. The currency *per se* had nothing to do with the question; it was all waste of time inquiring into the amount of money in the currency of each country; it was a question simply of the value of gold and silver in the currency or out of it. The value of all the gold in the world governed gold prices, and the value of silver governed silver prices. Until 1873 gold and silver divided the field. Yoked together they bore the whole burden of the trade of the world. What gave the value to gold and silver was not their use in the arts, but what Jevons called their residual use, which was simply their hoarding value. Up to 1873, the world was content to use the two metals, and it had done so from time immemorial. Not long ago there was a letter in the *Times* from Professor Max Müller, showing that, from the most ancient times, the two metals had been linked together. What nonsense it was to say that they could not be linked. They always had been linked until man in his presumptuous folly unlinked them. It was one of the fruits of the French and German war, and indirectly, our own folly in first disusing silver long ago; the evil we then introduced came home to roost. Until we retraced our steps, there was no remedy possible. All notions of buying up silver were worse than useless, except as a step to bimetallism, but they would be just as likely to retard it. He believed the Table giving the amount of silver in India was misleading; he should think even the coined silver exceeded, by three times, £180,000,000, and some people would estimate it at ten times. If India stood alone, and had not to pay this terrible debt to England, she might regard the whole question with complacency; but to what was her prosperity due? Simply to the fact that she had had, during twenty years, the inestimable benefit of a steady standard, while England had the very worst standard any country could have—an appreciating one. Now, the Indian standard was beginning to fall, but a falling standard was better than a rising one.

Mr. Alexander Del Mar in adverting to the criticism upon Mr. Robertson's admirable paper, said that many people who spoke on this subject knew but little about it practically. They neither knew the gold and silver produced, the circumstances under which it was produced, the history of these metals, nor the legislation which had taken place with regard to them. Gold and silver were commonly produced together, and could not be produced apart; they were eternally joined together—twin metals. He was a member of the Monetary Commission of 1876, appointed to examine the silver mines of Nevada, and take evidence regarding the probable future production of silver on the western coast. In carrying out his instructions, he called before him the three best informed men in California, Mr. Barr Robertson (the speaker of the evening), also Mr. Gansl (the agent of the house of Rothschild), and Mr. Valentine, who compiled the statistics on the subject, and their testimony was given in the official report. The evidence showed that gold and silver were commonly produced together, so that if you stopped the production of one, you affected, to a certain extent, the production of the other. Silver and gold had always been associated in legislation, from time immemorial, and dealt with at a fixed ratio. They were united in the Roman law, the ratio being twelve to one. This could be seen in the Digest of Justinian. This ratio remained unaltered for nearly thirteen centuries; there was no premium on either metal. No coin was ever struck by any independent Christian prince, except at the ratio of twelve to one for the whole period he had mentioned.

Mr. J. Biddulph Martin said he could not attempt at that late hour to reply to the paper or to make any special reference to India, but he might make a few remarks on one or two points arising out of the general subject. He must take exception to the statement at the beginning of the paper that the chief cause of depression of prices was the appreciation of gold, which was followed by another statement that the fall in prices was due to the increase in the purchasing power of gold. This was equivalent to a statement that the fall in prices was caused by the appreciation of gold. But to speak of a fall in prices or of an appreciation of gold was merely to state a fact in convertible terms. You could not say that one caused the other. Mr. Robertson came to the conclusion that prices had fallen from 100 to 68, and justified that by a reference to index numbers. Now index numbers were no new thing. The very same conditions which caused alarm now, filled with alarm the mind of Mr. Joseph Lowe about 1823; and he proposed very much what was proposed now, calling it a tabular standard of value. He put commodities together, and drew an index number. That was carried on by Mr. Poulett Scrope, Mr. Newmarch, Professor Jevons, and Dr. Giffen, and also by a committee of the British Association, of which he had the honour to be a member, and by a committee of the International Statistical Institute. He would not detain the meeting by going into all the details of the subject; but he might say that an index number, if at all perfect, ought to start from a period of average prices. They had heard to-night a great deal of

that year, unfortunate in every sense, 1873, which it seemed as impossible to keep out of a discussion of this kind as King Charles's head out of a certain memorial. Then, the index number ought to include every class of goods, including services, and it ought to be a weighted average, not a mere arithmetical average, giving each commodity its due proportionate weight. Then, again, there was the difficulty that you did not always use an equal amount of the representative class of one commodity selected as a basis. A fourth condition was that no commodity ought to be scheduled twice; but in any class of iron, coals, wages, and other commodities, entered very largely into the price. In formulating what might be termed a practical index number, you had to take natural products largely into consideration, but then barley and other cereals were largely used in the manufacture of beer, and you got cross figures, which were very difficult to separate. He might add that index numbers were not at all in favour with French economists. Mr. Barr Robertson, on the faith of these numbers, came to the conclusion that prices had fallen from 100 to 68, but it seemed to him that that proved too much, for if that were so, why did the Indian gentlemen complain that the £1,000 a year, which they received in rupees, was now worth only some £660. If £680 went as far now as £1,000 did a few years ago, surely they might say to them—"Go in peace; you are not injured." He did not find any disposition on the part of holders of fixed incomes to think they were better off now than they were, owing to the fall in prices. In fact, the question of the actual fall in prices could not be decided by such index numbers as were commonly quoted. To come to the profession of banking, with which he was connected, the only qualification of the evils assumed in the paper was that there might be some economy in the use of gold owing to the increase of banking facilities, but it was not allowed much weight. The fact was undeniable, as was proved by the fact that the increase of population had not been kept up with by a corresponding increase of either coin or note circulation. To what extent banking facilities had supplanted the use of coin or other currency he had endeavoured to ascertain, but found it very difficult even to estimate. But there were other causes in operation also, to which no reference had been made; such as facilities for transport and the enormous improvements in manufactures, which that Society had done so much to stimulate and encourage, whereby many articles were produced at less than half their cost a few years ago.

Sir Raymond West moved the adjournment of the discussion, as there was a good deal more to be said on the subject.

The Chairman said as the general feeling of the meeting seemed to be in favour of the motion, he declared the meeting adjourned to Thursday next. He said they could not separate without passing a vote of thanks to Mr. Barr Robertson, which was unanimously agreed to.

Adjourned discussion, Thursday, January 26th; Sir Alexander Wilson in the chair.

The Chairman, in opening the proceedings, said he must apologise for being in that position, but Sir Theodore Hope, who presided on the previous occasion, had been called abroad, and the Council had done him the honour to ask him to take his place. He had also a letter from Mr. J. M. Maclean, apologising to the audience for not being able to be present.

Sir Raymond West, K.C.I.E., said he felt some diffidence in addressing so capable an audience on this subject, especially after what was said by one gentleman on the last occasion, who professed to be thoroughly acquainted with the matter, that nearly all those who expressed opinions on this subject knew nothing about it. No doubt his opinion was that, on this subject particularly, speech was silvern, and silence was golden; but, in spite of that, he thought there was a good deal which was both interesting and instructive in what had been said in the discussion on this subject, which was one of such great importance that it deserved consideration from all possible points of view, and even if they brought different ignorances to clash with one another, a ray of light and truth might be elicited Although error was infinite, truth was invariably self-consistent. He would, therefore, offer a few remarks on what seemed the salient points of the paper, and he trusted Mr. Robertson would not consider, though he approached it in a somewhat critical spirit, that he failed to appreciate its great ability and value. The main propositions in the paper were these: (1) that there had been a very vast enhancement in the value of gold in recent years. (2) That silver had been, on the other hand, comparatively, if not quite, steady in value. (3) That this great enchancement of gold had also been attended with very mischievous consequences, and was likely to be attended with disastrous consequences to the welfare and commerce of the world. (4) That these disastrous consequences must and ought to be averted, and could be so chiefly by a much larger use of silver, and a diminished use of gold, in the currency of the world generally; and (5) that all these propositions, when rightly viewed, led up to the general support of the doctrine of bimetallism. That there had been a considerable enhancement in the price of gold within the last 25 years was almost certain, but that it had been on anything like the scale Mr. Robertson supposed, he could not bring himself to think, and the evidence brought forward was not at all conclusive. Looking back to the history of gold in relation to prices, he found that, in 1850, McCulloch pointed out that at that time, before any great fluctuations in the price of the precious metals had been observed, there had been a general

decline in prices, amounting to about 30 per cent. Even as far back as 1830, there was a statement in the *Quarterly Review*, supported by instances, that prices had even then fallen, and French authorities, too, referred to a decline in prices even before the revolutionary changes in the value of the precious metals with which they were now familiar. In 1850, 1870, and in 1890, the cause of this decline in prices was in great measure what economists had noticed before—the greater and greater application of machinery to the manufacture of the comforts and necessaries of life; and looking through the list of articles which had declined from 1850 to 1890, especially since 1870, it would be found that in five out of six the decline in prices could be accounted for by some improvement in manufacture, or some increased facility for bringing up goods to market, or by opening up some new and virgin fields, which before were unproductive. The extension of the application of steam to machinery, and the propulsion of vessels during the last generation, had exceeded anything before witnessed; and, to take one instance alone, ships could now be propelled at one-third of the cost of 25 years ago. This enabled the American, Indian, and African produce to be laid down in English ports at a vastly cheaper rate than was possible before. This had necessarily made corn and cotton cheaper, which, in a sense, might be called manufactured articles, and, going to more distinctly manufactured articles, the application of machinery in their production had been so enormously developed and successful that, without regard at all to any real increase in the value of gold, the decline in prices would, in nearly all cases, be accounted for. At the same time, there had been a certain rise in the value of gold, owing to the circumstances on which Mr. Robertson dwelt. There had been an enormous quantity demanded by the different States of Europe, which had set up a gold currency, thus creating a demand which exceeded the produce of gold of late years. The vast extension of commerce also required more of the precious metal to carry it on. One of the necessities which arose in the progress of manufacture was that which sprang from the greater division of labour; and the more labour was divided, the more necessity was there for money, on account of the greater number of operations, to be carried on. This was counteracted, to some extent, by the use of banking facilities; but still, as the division of labour proceeded, there must be an increased demand for the precious metal. He thought the demand for gold, outside the State demand, was in a great measure due to this, that industry and production had become in each recent generation more organised, and was carried on on a more wholesale scale. In a small and petty business the use of silver was natural and proper. So much was this the case that in England at one time it was difficult, if not impossible, to keep any large quantity of gold in circulation amongst the people; their needs were such that silver was more useful, and gold would not remain in their hands; it gravitated to those cities in which commerce was more highly developed. The relative value of gold in the commercial cities in the 13th or 14th centuries, measured in silver, and compared with what it was in the interior towns of Europe, showed generally that gold was more highly valued in those cities, the reason being that it was more convenient for carrying on extensive operations. There never was an age when, profits being cut down to so fine a margin, the necessity for carrying on things on a large scale was so developed as at present; therefore the balances which had to be paid were larger in the agglomerated sums, although perhaps the quantity of money used was not so great in proportion to dealings, and there was a great convenience in using the more portable metal. Gold, therefore, was naturally more used as mercantile and manufacturing operations assumed more and more a wholesale character. These were the principal reasons why gold had increased in value, but he could not believe that it had done so to the extent Mr. Robertson supposed. Of course the fall in silver was was only another side of the same fact, and that brought him to his second proposition. It followed from all reasoning, that silver being taken out of circulation to the enormous extent it had would decline in value as against commodities. The general principal was that the value of money, whatever its shape, if there was a free flow of it, was according to its scarcity, and when silver was made superabundant, by turning it out of the currencies of so many countries it was almost inevitable that it should fall, and the *primâ facie* view was that silver had considerably fallen. That was the view held by 99 out of 100, whatever the subtle arguments there might be on the other side. Silver had been taken out of the currencies of the world, and forced upon the East, and the quantities of silver which still came pouring in were infinitely in excess of what was required by the needs of the world as they were measured at present. Therefore, *primâ facie*, the view itself was a rational one, and was not discredited by the circumstance that other things had fallen also in value. If one could account for the fall in prices of other things by the improvement of manufactures, that did not at all show that there had not been a fall in silver, and that there had been a great appreciation in gold. It meant, he thought, that there had been a parallel movement from different causes, both of goods and silver as measured against gold. Eastern produce was forced down by competition as silver by superabundance. The third proposition was that this appreciation in gold, which he would call either an appreciation in gold, or a decline in value of commodities, had been a calamity to the world, and threatened to be a much greater one. Mr. Maclean on the last occasion argued that on the contrary it was a great benefit. He could not accept that proposition, and in a measure the proposition laid down by Mr. Robertson ought to be accepted. But what was it that occasioned the evil, and what was the extent of

it? It came apparently to this, and this was supported by the history of the contrary movement at the end of the 16th and the beginning of the 17th centuries. If gold became dearer, or goods declined very much in value, wherever a man had to pay mortgage interest or leasehold rents, and whenever he had to pay taxes to support the army, whose pay could not well be reduced, or to pay public creditors. whose claims could not be denied, he was submitted to harder terms, because, for a given quantity of goods which he produced, he got a smaller return in money, and out of that smaller return he still had to contribute to the inert classes on the scale of ten or fifteen years ago. At present the labouring and artisan classes had been so well able to hold their own that there was not in their case any material falling-off in wages all round, but on the whole there was an increase; and this again corroborated what he said about the falling in prices not being a sure indication of the real appreciation of gold. Artisans' wages were as high as they were; and, looking to any of those products in which human labour still formed a large part, there was no material decline. They paid as high a price for hats as before, because hat making was, to a very slight extent, carried on by machinery. Machine-made boots might be cheap, but hand-made boots were as dear as in his boyhood, and certainly ladies' dresses had not fallen off in cost. Houses were not cheaper, and carts and carriages were not cheaper than they were. No doubt jerry houses were run up with great ingenuity, but houses of the same quality were not cheaper. It would be very strange if they were, considering that the wages of those engaged in the building trade were distinctly higher. It had been said that the effect of this on India was as nothing, because the Indian producer got the same number of rupees as he ever did for all that he produced. Rupees had fallen, and produce had fallen in India, but only *pari passu*; and, therefore, the Indian producer was as well off as ever. If he were tied up within his own country, and had no communication with the outer world, it would be a matter of comparative indifference to him in what terms his medium of exchange was expressed; but then this was not so. If the rupee had remained at 2s., the difference to the Indian producer would have been that he would have had to sell at 10 annas what he now sold at a rupee. So far as he paid Government rupees on a settlement, he would have paid them the same as now, and, so far as he consumed his own produce, his position would be the same, but for all articles which he imported from abroad his position would be somewhat different; he would have to pay fewer rupees where he now pays more. The vital point of difference would be this, that, with the decline of the rupee, those millions which he paid to the Government, and which the Government handed over to gold creditors in this country, cost £6,000,000 or £7,000,000 a year, which was called loss on exchange; and these £6,000,000 or £7,000,000 would, if the rupee had not declined, have been spent in the country, and would have served either to lighten the load of taxation on the ryot, or to extend the communications of the country, to develop its resources, and widen the field of employment. In this respect, undoubtedly, the Indian producer had lost distinctly by the decline in the value of the rupee, and deserved all the help which the Imperial Government could give him. But the next question was raised in the fourth proposition, that the remedy was in the extended use of silver in the coinage of the world, and the diminished use of gold. Mr. Robertson had suggested, or adopted the suggestions of others, resting on reasons, which appeared to him not altogether of a practical kind. Mr. Alfred de Rothschild proposed, for instance, that England or Europe should buy up each year £5,000,000 sterling of silver. For the sake of illustration, he would suppose that England alone was to do it; £5,000,000 was to be taken off the market every year, which in five years would be £25,000,000. But with what result? If silver were a monopoly of a very limited amount, to take £25,000,000 out of it would have a material effect, but, from all he had read on the subject, beginning with Humboldt downwards, he believed what the writer said many years ago was perfectly true, that as yet we had only touched the efflorescence of silver, and that it could be produced in almost infinite quantities. If you took off £5,000,000, as the American Government had now taken off a large sum month by month, what was the result? You raised the price in the market, and gave encouragement to a further development of silver production. It was like ladling out the Thames with a teaspoon. It would produce no effect on the market, or if it did it would only encourage larger production. Then if you had those £5,000,000, what were you to do with the treasure? was it to be locked up in a cellar to remain there for ever? If not, it was only postponing the evil day, and making it more disastrous when it came. If it were locked up for ever, you were paying year by year £5,000,000, and at the end of five years you would have £25,000,000 invested in something which was absolutely of no use, because by the hypothesis it was locked up for ever. If it was an English transaction, instead of being invested in buying useless silver, it might be expended on the reduction of the National Debt, and it would pay off a great deal more than half the National Debt in the course of a century. But it would do the same for Europe that it would do for England. It would be a far better investment for the countries of Europe to lay out their money in reducing their debts than in locking up silver which would be useless to them, a mere encumbrance, by an operation which, after all, would only encourage a further production. The final tendency of Mr. Robertson's reasoning was that such experiments must lead up to bimetallism, and that the adoption of these remedies, which would be partial, but so far successful, would convince the world that bimetallism was the real

remedy for its evils. He wished he could adopt that view. He had suffered, as many had, by the reduction of the rupee, and for some time was of opinion that bimetallism was a feasible remedy; but, on a full consideration of the subject, he had been forced to a different conclusion. As the great discoveries and development of gold and silver production in the 16th century led to enormous increase in prices, amounting to more than 250 per cent., on what principle was it that the same thing should not apply to silver if it were produced in a redundant amount. It rested on those who said that this great production would not bring down the price of silver to prove it. Then the bimetallist said that the effect, if gold and silver were linked together, would be for the Government to give them currency at the ratio of one ounce of gold to 16 ounces of silver. Supposing the valuation of the world, as distinguished from that of the Governments, was that one ounce of gold was worth 20 ounces of silver, the result would be that no gold would be presented for minting; the holders would keep it back. Instead of gold prices there would be silver prices; gold would be circulating at a premium. Wherever there was commerce with a country having an effective and elastic demand for gold, it would be sent there, but it was quite possible there would be for sometime some small decline in the value of gold. If that amounted to anything that was important, almost certainly means would be found to bring the gold into use. They had only to look back into history to find that that had taken place before, and when an endeavour had been made in England, France, Greece or Rome, to make gold and silver circulate at particular values, those attempts had failed. Reference had been made to Professor Max Müller's researches, and he considered that the ratio of 12 to 1 was about the average value in ancient times, but that it was at all a fixed value he entirely denied. There were indications that gold went up and down in comparison with silver, just as it did in modern days. In the time of Philip of Macedon, the price of gold was lowered in spite of his attempts to establish bimetallism, and on various other occasions it rose in spite of the attempts to keep it at a particular level. In England, the same result had followed, and the general conclusion was that, in spite of attempts made by Governments, gold had maintained its place and silver, one rising and the other falling, so much so that in seven years in James I. reign, gold rose 21 per cent. in proportion to silver, in spite of all the efforts of that sovereign to keep them at a particular level. The instance of France in the present day repeated English experience, and was no instance to the contrary; but time would not allow of his going fully into that question. He would conclude by saying that he could not see that it would be possible to introduce gold and silver together, except on the level of perfect equality and freedom. That there was such a method possible he believed, but that you could ever prevent silver reaching its natural value, the cost of production, was opposed to all scientific reasoning, and would lead those who believed in it to disastrous consequences.

Mr. LESLEY PROBYN said he was rather disappointed, when he took up Mr. Robertson's paper, to find there was really no practical suggestion for benefiting the Indian currency system. Although he believed that, if bimetallism could be adopted, it would be the best solution of the Indian difficulty, they were nearly all equally agreed that it was not at present within the range of practical politics. He was, therefore, disappointed that no other remedy was suggested, and would simply allude to one which would commend itself to all bimetallists, as a step in that direction, and also had the great advantage of not being opposed to those sound principles of currency which were in favour in England, that was, an increased use of silver, as representative money. He first suggested that 13 years ago, and since then it had had the approval of many high authorities. It was approved by all the members of the Gold and Silver Commission, by Dr. Soetbeer, and by Mr. Goschen. Dr. Soetbeer, in his paper read before the last Monetary Conference, showed that no less than £75,000,000 sterling of gold was used for purposes for which representative silver might be used just as well. That was a large sum, and if it could be saved, it would have a material effect on the gold standard, for not only would it be saved, but it would give employment for a corresponding amount of silver. This was suggested by the German Government in the Conference of 1881, and if the British Government had agreed to discontinue coining any gold smaller than a 20 franc piece, on the condition of others doing the same, he believed it would have been agreed to, and it would have had a very material effect on the monetary system of the world.

Mr. R. L. EVERETT, M.P., said he was interested in agriculture rather than in India, but he had listened with great interest to what had passed at the last meeting, and Mr. Robertson had made a most valuable contribution to this great bi-metallic controversy. There were some things on which all agreed, one of which was that there had occurred an unprecedented change in the relative values of silver and gold; during the last 19 years they had diverged from one another in a way to which all previous history contained no likeness, and to such an extent that, at the present time, gold was 50 per cent. higher in value than silver, as compared with 20 years ago. A sovereign now purchased 16 2s. pieces, whereas formerly it only purchased 10. Very great inconveniences of many kinds had arisen from this remarkable and continuing divergence, and he could not help thinking that those who would look at all the facts available, must come to the conclusion that the change was really not in the silver, but in the gold. For many years there was a belief that the sun rose and set, and those who ventured

another theory were treated as heretics; but as the facts came to be understood, it was found that the heretics were right, and that the motion of the earth gave the appearance of rising and setting to the sun. So with regard to the value of gold and silver. The evidence was very clear. The record came on all hands that in silver-using countries silver had lost none of its purchasing power, or, if at all, only slightly, and only within the last year or two. During the larger part of the time the purchasing power of silver over commodities had increased to some extent, while, on the other hand, the purchasing power of gold over commodities had very largely increased. There was an abundance of facts testifying to this. In a silver-using country no inconvenience was felt by the masses of the people, but only on the part of those of them who had to transmute silver into gold to be sent to England. In gold standard countries, on the other hand, during the last 15 years, all who had fixed charges on their properties, who had taken properties on lease, found themselves year by year in increasing difficulties—so grest that the law had had to step in and interfere with contracts in a way that was unprecedented in history. Production of commodities in this country had become attended with very much less profit than it used to be, especially the production of the main staples of the country. Agriculture had not been in so depressed a condition in the memory of man as to-day. So far as he knew, in all the gold standard countries, the depression was felt equally. If the low prices were caused by improved methods they would not all be suffering, but the agricultural man in America was suffering as keenly as his brother in England. Where prices were crushed down in articles of production, simply from the decrease in the medium of exchange, there came first unprofitableness to the producer; and then his troubles led him, instead of extending his business, to contract it, if he was able to keep on his feet at all; then you had employment lessened, and the cry of the unemployed was heard in the country. All these things had been going on during the last fifteen years. Production had been attended with less profit, it proceeded at a smaller rate, employment had been less, and, if wages in all employment had not fallen, they had in agriculture, and the area and certainty of employment had sensibly diminished too. While this had been proceeding, those fortunate individuals who owned gold had been receiving their full amount, which had been of more value because of its increased purchasing power. It was a question between the creditor classes on the one hand and the debtor classes, and producing and industrial classes on the other. It was true as this change went on that the creditor had to take a less rate of interest, because the toll he was levying had become impossible, and the unprofitableness of production, brought about by the increase in the value of gold, had made producers less able to borrow and pay interest than they were before. The creditor benefited in the first instance, but in the end he too began to share in the suffering. The agricultural districts were full of cruel misery. Numbers of people who thought themselves in perfectly safe circumstances for the rest of their lives were beggared. Property which was considered as safe as the Bank of England was in that position that, as the saying was, the bottom was out of it, and every owner of land now woke up in the morning poorer than he was when he went to bed. This increase in the value of gold was not natural, but was purely the result of law. Step by step the progress of the divergence could be traced, as was shown in the valuable pamphlet by Mr. Henry Hucks Gibbs, the first step was taken when the Mint of France made a slightly different treatment in the silver brought to them to be coined in 1873. There was no divergence until then. It was only as the minting and currency laws of nation after nation had been altered in favour of gold, that this divergence had manifested itself. The alterations made resulted in a divergence of two precious metals, one from the other, the end of which, if nothing was done to counteract it, no one could foresee. Nation after nation had adopted the policy of favouring gold at the expense of silver, which was simply protection. In these days of free trade, the nations had taken to boycotting one metal, and to protecting the other, and as the areas over which one only of the two metals could be used were extended, so its value was forced up, but it was a purely artificial thing, and its general effect is to enrich the creditor and the bondholding classes, and to depress the debtor and industrial classes. The standard was changed in the United States by a trick, and apparently by fraud. The President himself did not know that the change had taken place, and the Congress did not know, but it was done by the interpolation of words into a statute passed for another purpose. The question was never so much as debated, and that being so, it was difficult to put from one's mind the idea that the changes recently made have been part of a conspiracy of the far-seeing money lenders of the world who saw an opportunity, artificially to increase the value of their property, regardless of the suffering that it would cause, unjustly, to the industrial and indebted classes. The one point on which he thought the money lenders would insist in the coming fight was very ably put by Mr. Maclean, viz., that cheapness was a benefit, and by Mr. de Rothschild, at the Monetary Conference, where he said that wheat at 30s. a quarter was better than at 45s. If that were so, without any regard to how the cheapness was produced, the natural thing would be to close the Mint to gold too, because the more you reduced the money in circulation the lower you would reduce prices. They would fall faster then than they do now when half the supply of money has been artificially cut off; and he recommended the adoption of these tactics to those who desired to have things very cheap. No doubt people would be able to get things very cheaply if all mints were closed, but would they be

better off? He did not know anything in a civilised country which people wanted more than money, for if you had not some of that you could not buy anything else, however cheap things might be; but the great bulk of the people had no money, except what they earned by their labour, or received in exchange for their produce. It appeared to him, therefore, that to artificially make a commodity scarce and dear which the people all wanted, was contrary to the argument of Mr. Maclean, which was that it was a good thing to make every thing cheap. Those who looked at the testimony of history with an open mind would see that, whenever money was contracted violently, it produced effects very detrimental to industry. In 1816, when it was expected that cash payments would be resumed, there occurred a great fall in prices, and, instead of being a blessing, it ruined large quantities of the farmers and mercantile classes. Then the Legislature postponed the return to cash payments for two years more, and immediately life and activity returned to commerce, prices went up, and people were better off. In 1819, the Act for resuming cash payments was passed, and small notes were to cease to be used after 1823; then ensued another terrible time of suffering, not caused by rising, but by falling prices; and, in 1823, things got to that pass that an Act was passed, giving the small notes 10 years more to run. That caused things to lift up a little, a rise in prices occurred, and it blessed the people instead of cursing them. In 1826, however, it was ordered that no more stamps for small notes were to be issued, and the notes were to cease to circulate after 1829. After that, there set in another time of falling prices and commercial distress, and the country nearly got into a revolution, but that was in consequence, not of rising, but of falling prices, produced by a contraction of the currency. The country was never really raised out of this condition of suffering until the blessed gold discoveries came. Under their influence prices rose, and with this rise in prices people got better off. Sir Raymond West spoke of the improvement in machinery, and so on, lowering prices, but they did not lower prices at the time of the gold discoveries. The influx of gold was more powerful to elevate prices than the improvements to reduce them. He hoped this question would be discussed fully, and then people would see that it was to their interest to have money—whether gold or silver—perfectly free, in order that there might be an abundance of it.

Mr. ALFRED KEYSER said Sir Raymond West had already anticipated a great deal of what he intended to say. He thought the other evening that he was in a company of pronounced bimetallists, but the sympathy with which Sir Raymond West's speech had been received led him to think that he was wrong, and that the view that bimetallism was not practical was more generally held. Mr. Chaplin, in a speech recently made, said that the City and Press were opposed to it, and that appeared to him was equivalent to saying that the persons in the best position respectively to form and formulate a judgment were opposed to the proposal. Sir Guilford Molesworth laid great stress on the fact that the British delegates alone were opposed to any change. The fact was that the British currency had not been altered within recent memory, and if, as bimetallists assumed, that the bimetallism which was in force in 1873 kept gold and silver at equal values, they might recur to it if they wished; but what had England to do with that? If, as Sir David Barbour and other bimetallists always insisted, the action of France and the Latin Union and America, in having a bimetallic currency, was sufficient to keep gold and silver at an efficient ratio, why should England depart from the standard which had been in force for nearly 80 years. Political economy was supposed now-a-days to be banished to the planet Saturn, but as Mr. Ricardo was his great uncle, he still retained some partiality for his doctrines. Mr. Ricardo, writing about the date the standard was fixed by law, said the gold standard was adopted, not by legislation really, but was absolutely in force before the Act of 1817 was passed, because no other was found feasible. At that time it was on account of the want of silver. Now silver was superabundant, and it seemed to him that if you had a bi-metallic currency, gold would be gradually driven out of circulation altogether, and silver would be the sole standard. Mr. Robertson told them that silver had maintained its value, or nearly so, whilst gold had appreciated nearly 38 per cent. Sir John Lubbock, in a letter to the *Times* that day, said 5 per cent., which was a slight difference. If silver had maintained its value, the public servants in India, who were said to have suffered so much, had no cause for complaint, because they got paid in a metal whose purchasing power was the same as it always was. Unfortunately, as they all knew, that was not the case. Wages had not fallen, but rather the contrary; certainly servants were better paid, and the British workman got more wages and lived better. For that reason the fall in silver materially affected those who served in India, and the finances of India. The Indian Government was in the position of being the heaviest loser itself, and was called upon also to compensate its servants. He was generally in accord with Sir Raymond West's argument, but he did not agree with him in thinking that bimetallism, or a great rise in silver, would at once tend to relieve the Indian taxpayer. Sir Raymond said, if the rupee were at once raised to the value of 2s., £5,000,000 or £6,000,000 annually would be free to be spent by the Indian Government in public works, and so on. But the effect seemed to him to be that the Indian taxpayer paid £5,000,000 or £6,000,000 less than he would pay if silver were at 1s. 10d. or 2s. If he now paid £80,000,000 of rupees, which were worth 1s. 3d., if their value were raised to 1s. 10d., the purchasing power of the rupee would be immensely enhanced, and he would pay a very much larger sum. The £5,000,000 or £6,000,000 which

Sir Raymond West said the Indian Government would spend had been fructifying in the pockets of the people who had had that additional amount to spend. He served during the famine in 1876, and the nearest approach to it was last year, 1891-2. There was an absolute failure in the crops in a great portion of the country, and it was a very serious affair, but he was much struck by the enormously increased prosperity of the people. They paid the whole of the revenue, as in ordinary years. They would not resort to relief works, but were making works and spending money in all directions, sinking wells, and improving their own property. He was quite sure the Indian producer had benefited very much by the fall in the value of silver, and consequent reduction of the amount levied by taxation. Of course there was a great financial difficulty, and, if bimetallism could be introduced, the rupee would rise and the Indian Government would be able to levy extra taxation without difficulty. It was a great problem, and one to which he would offer no solution, as being outside the subject at present under discussion.

Mr. George Howell, M.P., said it was very difficult to know where to start in a discussion of this kind, going over such a wide area. The speakers who had taken the opposite sides to Mr. Robertson had pretty nearly answered themselves. The first speaker, although he did not agree with bimetallism as being a practical subject at present, said it was one of the things we must come to; but if so it was the right thing it seemed to him, and it should be hurried on as speedily as possible. They were placed in this difficulty in discussing the question, that they seemed bound to use the terms invented by their opponents, and talk about cheapness and appreciation of gold as if they were one and the same thing. He was in favour of cheapness as absolutely as any one in the room, but only cheapness naturally and honestly produced. He was not in favour of cheapness by any system of roguery, by whomever it was done. He was not in favour of cheapness caused by over-trading by fraudulent traders who would bring down market prices, and bring themselves to ruin, and a number of others with them, still we had been doing that kind of thing, to some extent, in the money market for the benefit of those who were simply the money changers, and not producers. But there was a difference between gold as currency and commodities. Already it had been spoken of as if the currency of a country was a commodity in the ordinary sense with other commodities, just the same as many of the old political economists and many monometallists never could see the difference between labour as a commodity and the commodities produced by labour. They were just beginning to understand now that labour was not a commodity in that sense, and in the question of currency, he begged to differ most emphatically from the gentlemen who talked of the currency of a country being a commodity in that sense either. On the contrary, it was the measure of the value of commodities. What else could it be? They could do without money altogether if it were placed in any other category. The currency of a country should be the measure of value, and the more they could approximate to a measure of value all over the world the better it would be for all the world. Why should you have a standard yard—like gold for the present purpose—that should consist, under ordinary circumstances, of 3 feet or 36 inches, and keeping your gold standard as a yard measure should, make people give 40 inches for it? Fraud must come in somewhere—somebody must be injured. Mr. Maclean based the whole of his argument on India on the endeavour to show how India progressed. No doubt it had progressed, and so it ought, seeing the enormous amount of money poured into that country to develop her resources, but he would say of Mr. Maclean and others that whilst India had enormously progressed in a variety of ways, our trade with India to-day had not increased more than about £1,000,000 sterling per annum within the last 12 years, on the average. He was not speaking of the aggregate trade, but the English export trade of India. With regard to the imports from India, on the contrary, our averages were less than they were in the sixties; but India had been making some progress in other directions. He did not grudge that advance to India; on the contrary, he should like to see her advance more rapidly, but they should take care, especially as it could be done with an alteration in the currency, that the trade of the mother country should go on rapidly increasing, instead of throwing that trade into the hands of other people, who had no sympathy with either us or India. It was only natural that a silver-using country, for its own sake and protection, must go on dealing with other silver-using countries. That was why India, China, and Japan were getting nearer and nearer to each other. After a careful investigation of the figures with regard to the East and the Southern States of America, he thought, if we did not take care, the greatest outlet of our produce in this country, viz., in silver-using countries, would go into the hands of either the United States, with its increased silver currency, or into the hands of some of the other States, which would make an approximation to them. Following out the arguments used by Mr. Everett, it was well-known that, taking the four great countries of the world, the United Kingdom, the United States, France, and Germany, the total money of England, so far as it could be estimated, was less than any of them. Current coin in England was £115,000,000; the United States, £246,000,000; France, £333,000,000; and Germany, £134,000,000. Here, with an expanding trade and a largely-increasing population, we had, a little while ago, in order to save ourselves from a terrible crisis in the City. to go and borrow a couple of millions from France, That was a pretty condition of things for the United Kingdom that held the key to the industrial position

all over the world. That was simply because we had such a small reserve of gold in the coffers of the Bank. We had not a large amount of silver in circulation in comparison with other countries, for even Germany, although it demonetised silver, had one-third more silver in circulation than we had. Whatever might be suggested as a means of relieving ourselves from the condition into which we were getting by the divergence of gold from silver, anything which could be done to bring about an equilibrium he should support as earnestly as anyone. If they could get France or any other country to extend the use of silver so much the better, but after all if England was to hold her position as mistress of the world we should have to go back to the position in which we were prior to 1873, not by actual law in this country, but by the operation of law in another country which was in close connection with it, where gold and silver would be rated to each other at something like their actual value. It was only when Lord Sherbrooke (then Mr. Robert Lowe) was Chancellor of the Exchequer, that a measure was abolished which had hitherto been the law, that you could carry silver to the Mint just as you could carry gold. It was only just because Mr. George Tomline wanted to put it in force that Mr. Lowe hastily repealed that law. The ratio need not be discussed, for as soon as the nations of the world began to see the necessity of approximating these two metals, as the currency of the world with a relative value to each other, silver would rate itself to gold as naturally as any law in the universe.

Col. F. S. Terry said Mr. Robertson, in his observations on the appreciation of gold, did not mention in the succession of events that a general fall of prices was slower than the appreciation of gold. It fought its ground stubbornly, and still more so did the fall in the cost of production and wages. It was quite possible to have a continual fall of prices, and yet the whole time those prices might be above any possibility of extension of trade. That was the case at present. Going down to the workmen, the fall was resisted with a power which could not be conceived at present. There was threatened a social upheaval. As regards the fall of silver, Mr. Robertson was inclined to minimise that, and thought there was only a slight fall of 7 per cent. He did not think the tables published took into consideration that with the increased production in India there was a large appreciation of silver due, and therefore the total depreciation of silver should be that appreciation plus the per-centage allowed by the tables. The generally received view that the two metals had parted in opposite directions, one appreciated and the other depreciated ,was correct. In India productions was very much increasing, and there would be a very great period of prosperity, but for one thing, and that was the enormous increase of gold obligations. The gold obligations necessitated an increased taxation, and this might be the cause of discontent and political disturbance, so that from both sides, whether from the appreciation of gold in the West, or the depreciation of silver in the East, it came to the same point, discontent in the labouring classes. That was the answer to those who would leave things alone; they could not be left alone. The evil was in the unnatural difference in the value of the two metals, and something must be done. One of the great causes which affected silver was the token system. Silver was taken in enormous quantities, not for use as subsidiary money, but for supporting a gold value. In America this had been carried to such an enormous extent, that altogether from £250,000,000 to £500,000,000 sterling of silver was bearing a gold value; and this enormous amount of silver, with the great difference there was between the gold it represented and the silver at which it was valued in the market might at any time break away to a discount, and then large amounts of gold securities would be shaken in credit. The remedy he proposed was different to anything which had been mentioned yet. He looked on the two metals simply as commodities, and both as at artificial valuations. The only way in which you could get commodities to arrive at a natural value was to give them every facility natural to the particular market, and those facilities natural to the precious metals were mintage; therefore, they must give mintage to silver as well gold, but each must have a mintage to itself. The *modus operandi* in our own country would be this: a merchant, having in his business 1,000,000 ounces of silver, would send a portion of it to the Mint. The Mint would coin it into a currency of its own; on the model of the Indian currency, but, instead of rupees, he would call them albas. They would be sent to the Bank of England, and the remainder of the bar silver would be sent there also. Thereupon the Bank of England would be authorised to issue alba notes, and these would have effect as currency, and he would be able to trade with them When he made the proposal sometime ago, he was confronted with two objections, first, that these albas would interfere with our £ s. d., or if they did not, it would be because they were not used, and, therefore, they would be no use. It had been found where there were two currencies at the same time in a country, one ruled prices, and the other fluctuated in the market. When you had two currencies in England, for about fifty years they only intermingled, because they were complemental to each other, the silver having no large pieces, and the gold no small pieces. But in this case our £ s. d. would be left untouched. As for no use being made of the silver, it has never been known in history that a coined currency was left untouched by business and speculation; he would confidently leave this to the silver market to take care of. He would have all the little silver markets of gold-using countries provided with the facilities of silver currency, and would feel confident that the little markets would grow to big ones. He would have all

silver-using countries also provided with a second currency in gold; and thus every country would, while retaining its own currency as the fixed standard ruling prices, have a second currency of the other metal, fluctuating in value quite independently in the market. These second currencies would be of great value in international trade. The two precious metals, being thus equally free in the markets of the world, all artificiality of values would cease, and natural ratio would follow.

Mr. MARTIN WOOD said he would only offer a remark or two on the principles of the question. International trade was essentially barter, and being entirely voluntary, the rate of exchange was simply one of the items in the cost of the transaction. In each case it was considered amongst the rest, and whatever the value of the metallic currency inside each country might have that did not affect the profit of international transactions. On the other hand, the question had been spoken of as to what was money. Money was simply legal tender, whether paper or coin. It was that which in any country the sovereign authority made legal tender available for debts or taxes. It would be seen, therefore, that there could be no such thing as international money. Gold was readily appreciable, and easily removed about; still it was not money, it was a commodity in the same way as Colonel Terry would have silver, giving it facility to be coined. This would affect a large part of Mr. Robertson's paper, especially some parts which he confessed it was not easy to understand or follow. There was a portion, however, in which he fully agreed, that was where Mr. Robertson pointed out the bearing on the current controversy in India, as to the proposal to make an artificial value for the rupee. If a gold standard were to be forced on India, and the rupee coinage curtailed, Indian prices must fall. He emphasised all Mr. Robertson had said on this practical question, because so many persons had lately proposed to stop the automatic coining of the rupee, without realising the certain fall in prices which would take place, with such consequences as could hardly be foreseen. The difficulty was one of finance rather than one of currency.

Mr. BARR ROBERTSON, in reply, said Mr. Maclean started by saying that he had delivered an essay on bimetallism, but in nine-tenths of the paper it was not even referred to; he only touched upon it as a point for future consideration. His point was to demonstrate the appreciation of gold, the fall in gold prices, and the comparative steadiness of silver. Bimetallism was a system which, in his opinion, would be of advantage; but it was the facts in regard to gold and silver which he came there to demonstrate. Mr. Maclean suggested that he had said low prices were a calamity, but throughout the paper the fundamental distinction was drawn between the different causes of low prices. A large harvest of wheat or cotton gave low prices, but though the grower received a lower price, he had a larger quantity to sell; there was a benefit to the community and a benefit, or, at any rate, no loss, to the grower. There was a wide difference between such low prices and those which came from scarcity of gold. He had never suggested that India should repudiate her public debt; but what did Mr. Maclean say on this very point? It was a pertinent question for those interested in India. He said it was due to the very important economic fact which would have to be taken into serious consideration some day, that India was obliged to export £17,000,000 worth of produce, equal to £25,000,000 in rupees at present prices, in order to pay the interest on her debt to England, and so on. His point was this. Mr. Maclean said to-day India was giving £25,000,000 in rupees per annum to pay a debt of £17,000,000. He said, and he repeated, that the time had now come when they ought to consider how much farther this process of levying unjust taxes on the Indian taxpayer was to go on, for the benefit of the holders of Indian gold securities and indebtedness. Owing to the contraction of the currency the holders of securities and fixed charges were gradually absorbing more and more of the other interests in this country. There were probably about £4,000,000,000 sterling of fixed securities in the United Kingdom, and centring chiefly in the City of London, and to-day these £4,000,000,000 commanded £6,000,000,000 at the valuation of 20 years ago. Take the case of someone who 20 years ago put £100,000 in Consols, and of another one who put £100,000 into wheat lands. To-day the £100,000 in Consols was still there, but the land would not sell in all probability for more than about £60,000; and, in the meantime, the City man with his Consols, backed up by the City Press, decided that this was a good system, because England is a creditor nation. Yes; but how about the debtor? How about the man who put the money into the land; where was his £100,000 gone? Gold had appreciated; there was less of it; it had dragged down gold prices; and to-day the land was only worth £60,000. If there had been sufficient money to maintain prices the land would be worth £100,000 and the Consols £100,000. His point was, that if prices were being scaled down, certain fixed securities should also be scaled down. It might be repudiation, but he did not so call it; it was justice. The Australian farmer was paying $1\frac{1}{2}$ bushel of wheat and $1\frac{1}{2}$ lb. of wool for every bushel of wheat or lb. of wool he borrowed 20 years ago; was that justice? That was the point which required looking into, the injustice of an appreciating currency, causing all the producing interests of the world to contribute to the London money market a totally disproportionate amount of their produce to the amount they borrowed. As to the statistics of Indian currency, he took them from current authorities, and estimated there were probably about £180,000,000 sterling, or

2,700,000,000 rupees in current circulation. Mr. Chapman thought there might be ten times that amount, and said all the silver hoarded must be reckoned. In his opinion hoards had nothing to do with the value of silver. The value of commodities, and of silver as well, was determined by the quantity in circulation, by the visible supply, as one gentleman called it. The hoards of India were no better for the purpose of influencing prices than silver in the mines; it was locked up, no one could get at it; it did not come on the market. The price of gold and silver depended on the quantity of money in circulation in the gold and silver countries respectively. If you got rid of all the silver and and paper money in the gold standard countries, the gold would have twice the purchasing power it now had. If you had £640,000,000 sterling in gold money, and £650,000,000 in silver and paper, and if you abolished all the silver and paper, the gold countries must continue their business with the £640,000,000 of gold; if so, they could not have the same prices as at present with £1,300,000,000. The price of gold was determined by the £1,300,000,000, viz., all the money in use under the gold standard. If you had 400 odd million sterling of silver also circulating the same as if it were gold, it was quite clear that, if that were withdrawn or destroyed, it would cause a further appreciation of gold. The value of gold was diminished by the other money which circulated with it; destroy that, and the gold must have a much greater purchasing power, and prices must fall further. He next came to Sir Raymond West's valuable discourse on the historical and practical aspect of the question. He (Mr. Robertson) had not gone very far back—only to 1846—because at a single meeting the time was limited. He wished to deal with the present, and with facts and figures which had occurred in the lifetime of the present generation. Sir Raymond West said there was a decline in prices before 1850, that was his argument, that gold was falling off. According to all authorities, the French and Continental revolutions were precipitated by general distress, produced by the absence of gold and silver; and then the Australian and Californian discoveries came in, to start England on such a period of prosperity and activity as the world never saw before. It was said that wheat was cheap, owing to cheapness of transportation and abundance of supply. That was theory; but he had produced figures, showing that facts were contrary to the theory. We had less wheat consumed per head of the population in these islands in the eight years from 1884 to 1891 than in the eight years from 1872 to 1879. According to calculations he had made from official statistics, and those of Lawes and Gilbert, from 1872 to 1879, the total consumption of wheat in this country was 357 lbs. per head; and in the eight years from 1884 to 1891 it was only 348 lbs. But in the first period the price on the average was 51s. 2d. per quarter, and in the period when rather less per head was consumed, the average price was 32s. 10d. In the later period, with a smaller quantity, according to the law of supply and demand, the price ought to have been higher, whereas it was 36 per cent. lower. There had been no excessive supply. Why should the price be lowered if it was a question of supply and demand; but if it were a question of currency, one could see where the 36 per cent. could be lost. Sir Raymond West said silver had been forced on the East, and being redundant had fallen in value; but we had the Indian Government statistics on that subject. In the 15 years, from 1860 to 1874, the average coinage of new silver in India was 6,580,000 tens of rupees per annum. In the 15 years from 1875 to 1889, the amount was 6,530,000, so that practically the average was the same. The population of India went on increasing, and the demand for silver; and, consequently, one might predict that silver prices must have fallen simply because silver did not flow to India in excessive quantity. To show how closely the facts of prices followed the facts of currency, in the first and second periods, as there was no change, and, consequently, the demand being greater, silver prices ought to have fallen, and they did fall. But take silver prices in London, where there were no disturbing causes, and taking the *Economist's* leading commodities during the whole period of 23 years, with the exception of 1889, when the average price was just above par, 101, and on January 1st, 1893, 107; until last year silver prices in London were lower than they were 20 years ago. The consequence was, if silver had been in excess in the markets of the world, silver prices would have been very much higher, as they were in gold after the gold discoveries. But there was no such thing. The idea that silver went to the East, was a mere theory, not a fact. In the last three years, 1890, 1891, and 1892, instead of coining only Rx. 6,500,000, they coined on an average Rx. 8,780,000. There was the beginning of a larger movement of silver to India in the last three years, and the consequence was the rise in silver prices in London which had followed the larger supplies of silver in the markets of the world. India being a typical silver country, received recently more silver, but that was only a question of the last three years; the depreciation of silver in the East hardly existed at all. He did not deny that economy might have taken place in production but that would affect an article as much when valued in silver as when valued in gold. To-day, as compared with 20 years ago, the prices in India were 50 per cent. higher than they were in London for the same articles; they were higher in Indian money, in rupees. If the average value of commodities in London was 66, the price in India was about 100, the same as it was about 20 years ago. Sir R. West said it was due to other causes, but when the currency difference between gold and silver was 50 per cent., that was quite enough to account for it. It was quite true that in many respects prices were unchanged, in a Bond-street shop, for instance, you paid the same price for clothes and

hats; but you were not supposed to ask the price in those places, but simply to pay the bill when it was sent in. He called these conventional prices; but if you went to Mincing-lane or Mark-lane, you found a change in prices there. They did not depend on conventional prices, but on the prices of the world, as shown in the great marts of commerce. Then it was said how foolish it would be for this country to buy £5,000,000 worth of silver and lock it up. He did not propose they should buy anything to lock it up, but it would pass into the currency, and have its effect there. He was in favour of adding silver to the gold currency. If they had not enough gold, why not add something else to it? Why starve the people and drive the landed aristocracy off the land, and ruin the farmers and other producers, if there were some method which would enable you to bring up prices and do justice to everybody. Why should the millionaire unjustly demand his £100 when the farmer and the landowner in the home counties could only get £60 of his £100? If enough money could be added to the amount in circulation, prices would be raised, and the landowner, and the farmer, and the man in the City would be on the same level. But, unfortunately, the City and the Press, were hostile to any negotiations which would interfere with the conditions which gave them this enormous advantage over all the producing classes of the country. In the London Press, you could hardly find a single paper which would advocate a change. There was this singular fact—distress all round admitted by everybody, gold appreciated, and the burden of debts becoming enormous, and yet nothing was done. In the year 1891, the production of gold alone was £25,000,000 sterling, and of silver, valued at the American rate of 16 to 1, £37,000,000. The man who did not know anything about it said, here you have £37,000,000 of silver and only £25,000,000 of gold; but there was an explanation. The United States, out of those £37,000,000, coined £14,000,000, and added it to its gold money; and the consequence was that, instead of having £25,000,000 of gold and £37,000,000 of silver, you had £14,000,000 of silver added to gold, making the amount of gold and silver passing as gold £39,000,000, and the amount of silver only £23,000,000. This was why India had not been receiving such enormous quantities of silver. Since 1878 the United States had been coining, on an average, £4,000,000 or £5,000,000 annually, and now it was £14,000,000. They had taken up the surplus silver; but for that, silver prices would have risen in India. But the United States did do this, and they had offered to Europe over and over again to join them in any method—not so much to help silver as to help gold. Silver was not suffering; it was gold which was suffering. What was wanted was to help gold, so as to save the fall in gold prices. If there had been an excessive quantity of silver, it would have flooded India; but that had not occurred. India had only increased her silver coinage from Rx. 6,500,000 to Rx. 8,780,000 in the last three years, but even then there was an exception, for while in 1891 the total quantity of coinage in India was Rx. 13,000,000 odd; in 1892 it had dropped to Rx. 5,500,000. In the last three years about Rx. 2,000,000 had been added, that was all which had gone to help silver in India to become depreciated, and silver prices to rise. It was quite insignificant, and might continue, or might not; that depended on the policy of European countries. It would not if they would purchase silver, not so much to help India as to help themselves. India could get enough silver, but we could not get enough gold. Mr. Alfred de Rothchild's proposal was that we should take in this silver to help ourselves, to try to avoid the fall in gold prices. If it were carried out, it would prevent £5,000,000 going to India, China, and Japan, and, so far, would be a benefit, only the amount was too small. Sir Raymond West suggested that they should pay off the National Debt rather than lock up silver, but what was the use of doing that? Assuming that the National Debt, to-day, stood at £700,000,000, the farmers and producers of this country must find goods and commodities valued at £1,050,000,000, if it was to be paid off in commodities, as compared with 20 years ago. Those £700,000,000, to-day, purchased so much more of the commodities of the producers, that it required £350,000,000 worth more goods to make up for the change in gold. If £700,000,000 worth of commodities, 20 years ago, was the debt, to-day £350,000,000 had been added to it. Chancellors of the Exchequer plumed themselves on paying off a few millions, but what about the £350,000,000 they allowed to accumulate? that was the point. What was the use of paying off £10,000,000 or £20,000,000 if you were adding hundreds of millions to the burden. Of course, whilst there was a scarcity of money, prices must shrink. They often heard that bimetallism was a failure, and had never succeeded; and Sir Raymond West came and gave them a long disquisition on the failure; but he had taken the trouble to write over specially to France for information, and they said the man could not be found there who, in his banking account or in his business, ever knew any difference in gold and silver from 1803 to 1875. Sir Raymond West and other gentlemen were dwelling in the cloudland of theory, and came forward with statements which were entirely without foundation. He again gave an entirely erroneous idea, when he said the coin price might be at 16 to 1 and the market price 20 to 1. Imagine anyone in possession of £1,000 in silver at the time France received silver at the Mint, was he going to take £750 from some private individual, when the Mint offered him, in the best money the country produced, £1,000. The thing was preposterous. It was not merely his word; any French bank would tell them that Dr. Giffen's and all these theorists' views were simply absurd. It was difficult to bring these gentlemen down

to a positive examination of facts; but, fortunately, there was the Gold and Silver Commission, which sat from 1886 to 1888; and there was the opportunity for the monometallists to offer their evidence. There were six monometallists and six bimetallists on the Commission, and both found that, in the 200 years from 1673 to 1873, gold and silver remained in London at nearly the same point, never rising or falling more than about 3 per cent., and this they all attributed to bimetallism. When they came down from the cloudland of theory to fact, they had to accept this, that no man was going to be foolish enough to take less than he could get at the Mint for his silver. Why should he? The reason why silver varied a little here—it did not in France—was that as we offered £3 17s. 9d. at the Bank of England for an ounce of gold, so in France you could, before 1873, bring either silver or gold to the Mint, and get the fixed proportion of 15½ to 1. He had figures showing that France coined, from 1863 to 1875, £322,000,000 of gold, and £217,000,000 of silver, all on this ratio. They were told it was a failure, and that the ratio never existed; but Frenchmen said nothing else ever existed from 1803 to 1873. At the Monetary Conference of 1881, all except the English delegates were in favour of bimetallism, and how could it be this absurd and discredited thing when all the leading statesmen of Europe and America were in favour of it then; and if they were not so at Brussels it was because they said they could not do anything if England opposed it. It was not because they did not believe it could be carried out, but because they believed some nations would not join in the bimetallic movement unless England took its share. Why should it not? Why should it not go in with the seventeen or eighteen leading countries of the West, and enter on a great progressive movement for the benefit of mankind? We were spending enormous amounts on education, and other objects to benefit mankind, and why should we allow the English labourer and artisan to starve, and the farmer and producers to be ruined? But the politicians said no, and about the question whether the burden on the future should be further increased by the scarcity of gold, they were silent. An illustration of the difficulties with which they had to contend was afforded by a letter from Sir John Lubbock in the *Times* that morning. If one gentleman in the country could be chosen to represent commercial knowledge, science, and finance, Sir John Lubbock was the typical man; and in that letter he informed them that gold, in his opinion, had appreciated 5 per cent. How did he make it out? Some gentleman, whose name he forgot, had laid it down that all rents in England had fallen 20 per cent., and as gold had risen 30 per cent. there had been no fall in gold prices, indeed, there was 10 per cent. to the good; the fact was, the fall in rent was the rise in the purchasing power of gold. Sir John Lubbock implied that when gold rose, prices went up; but it was just the reverse, when gold rose in purchasing power, prices went down. The consequence was, Sir John Lubbock was going to set off an imaginary rise of 30 per cent., which never existed, against a fall of 20 per cent., which he said did exist. If rent had fallen 20 per cent., which was no doubt true, prices had gone down 30 per cent. or more, and there was nothing to set off. The scarcity of gold had brought gold prices down more than 30 per cent. But it was a strange mistake for Sir John Lubbock to make, to quote the rise in the purchasing power of gold, as if it was a rise in gold prices, when it was just the reverse.

The CHAIRMAN said if the hour was not so late he should have been tempted to convince Mr. Robertson that all the members of the Indian Section did not hold the visionary ideas of the question which he so much deprecated; but as it was he would content himself with proposing a hearty vote of thanks to Mr. Robertson for the very eloquent, painstaking, and able way in which he had brought forward this important question. He congratulated him especially on his peroration, in which he had made a vigorous assault on a very weak place in the armour of his opponents.

The vote of thanks was carried unanimously and the proceedings terminated.

EIGHTH ORDINARY MEETING.

Wednesday, Feb. 1, 1893; SIR DOUGLAS GALTON, K.C.B., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Blakely, William, Melville, Queen's-road, Boscombe-park, Bournemouth East, Hampshire.
Church, G., Building Works Office, Royal Arsenal, Woolwich.
Crackanthorpe, Montague, Q.C., D.C.L., 65, Rutland-gate, S.W., and Newbiggin-hall, Westmoreland.
Eyres, Henry Charles, Millfield-cottage, Millfield-lane, Highgate, N.
Gibbons, Charles Preston, 5, Marine-parade, Gravesend.
Grindle, George Annesley, 8, Great Winchester-street, E.C.
Laing, John, 3, Mentone-terrace, Newington, Edinburgh.
McCullough, Frederick William, 7, Chichester-street, Belfast.

The following candidates were balloted for and duly elected members of the Society:—

Ault, William, Swadlincote, near Burton-on-Trent.
Bagster, Robert, 15, Paternoster-row, E.C.

Bond, Captain F. G., R.E., Bombay, India.
Brunton, J. Forrest, East India Tramway Company, Bunder-road, Karachi, India.
Douglas, Prof. James, 99, John-street, New York, U.S.A.
Firebrace, Lieut.-Colonel Frederick, R.E., Bombay, India.
Haite, George Charles, Ormsby-lodge, Chiswick.
Hughes, Arthur Saunders, Compton Knoll, Plymouth.
Lamont, Robert, Sturrock-street, Kilmarnock, N.B.
May, W. Costall, 1, Lansdowne-place, W.C.
Oertel, Frank Oscar, Lahore, Punjab, India.
Saltren-Willett, Lieut. A. J., R.A., Royal Arsenal, Woolwich.
Simkins, A. R., care of Fritz Otto, 21, Shaftesbury-road, Ravenscourt-park, W.
Walker, Frederick, 7, St. Cuthbert's-terrace, Blackhill, Durham.

The paper read was—

THE PURIFICATION OF THE AIR SUPPLY TO PUBLIC BUILDINGS AND DWELLINGS.

By William Key.

I shall briefly describe to you some of the results obtained in the application of my method of purifying the air supply, in conjunction with the application of the downward system of ventilation to buildings.

To the science of chemistry we are indebted for the means of ascertaining, and for the facilities we now possess of clearly perceiving, the state of the air of interiors of buildings; the skilled analyst can place before us carefully compiled statistics, by which we may judge whether the means adopted for the purification of the air be effective or otherwise; and, on our discovering its condition, the usual manner of giving expression to our opinions is by stating that the building is well ventilated, or that it is badly ventilated.

The efforts towards the purification of the air have hitherto been chiefly directed towards accomplishing the desired purity by what is known as the *upward* method of ventilation. I cannot claim to be a chemist; but the knowledge gained in the course of an extended, although it may be considered a somewhat short, experience in point of time, leads me to conclude that all the arguments which led to the adoption of this method, and to the condemnation of the *downward* system, have been based upon results obtained through faulty application of the latter, owing, chiefly, to the failure to renew the air of the apartments in a thorough and proper manner, and with sufficient frequency, together with the inability to do so without creating draughts—these being even more objectionable than a want of proper ventilation.

The researches of the late Prof. Carnelly, of Aberdeen, and of his assistants, while investigating the subject of the ventilation of schools, show us that in the schools ventilated mechanically, by the downward system, a very superior condition of the air existed in them as compared with those schools ventilated naturally; in the former* the average volume of carbonic acid was only $\frac{3}{5}$ths, organic matter $\frac{1}{7}$th, and micro organisms less than $\frac{1}{9}$th of what they were in schools ventilated by ordinary methods.

Towards the end of the year 1891, an opportunity occurred to me to ascertain the relative advantages or disadvantages of the system of mechanical ventilation by extraction as compared with that of impulsion, and the relation both these mechanical systems held to schools ventilated by open windows, doors, and cowls.

After several tests in schools ventilated on each system, it was clearly demonstrated that in none of the schools examined and ventilated mechanically by extraction—even in a new school opened for a week or two—was the air found to be more pure than in those examined, and ventilated naturally without any mechanism; while those schools ventilated mechanically by impulsion, and heated by high-pressure hot-water apparatus, upheld the reputation for purity and freedom from micro-organisms as found by the late Prof. Carnelly.

Extraction mechanically, and natural ventilation may thus be classed together as equally defective, the bias, if any, being in favour of the latter as compared with the former; let me explain a circumstance which will go far towards showing how that these systems do not remove bacteria at or near the flood level; Mr. John Foggie, F.C.S., who conducted these analyses, had previously made an examination of the air within a village school. At the time of his visit the windows on both sides of the class-room were full open, to allow a free movement of fresh air through the apartment. Under such conditions we would naturally conclude that the air these children were inhaling would be of great purity, the rural village being remote from any large city or town. The number of micro organisms obtained from each litre of air showed conclusively that the free movement of air above the level of the window sills in no way

* "The Problem of School Ventilation."—T. Hector.

reduced the number existing in the air on a level with the heads of the scholars. These were quite as numerous as had been found in similarly ventilated schools in populous cities, namely 70 micro-organisms per litre, or 2,000 in each cubic foot of air.

Anything, and everything, which adds to the impurity of the air within our buildings, or is detrimental to our health or our comfort, ought to be brought within the reach of the means best adapted for their removal. Of these impurities I have noted down the following:—

1. Fog.
2. Inorganic matter, being the floating impurities found in the atmosphere of all large cities and towns, as smut and dust particles.
3. Organic matter, micro-organisms.
4. Carbonic acid.
5. Moisture—dryness.
6. Draughts.

These, probably, are the occasion of the greatest discomfort, and requiring our attention the most for their removal.

The problem before us is, how shall we free the air within our buildings of these impurities, and render it bright, pure, and wholesome, irrespective of the condition of the outer air, and during all seasons of the year? This we can only accomplish by methods requiring the aid of mechanical appliances.

So long as we have an indifferent system of ventilation, and a consequent indifferent supply of fresh air, we do not observe very particularly the amount of organic matter brought into an apartment with the air, and deposited on the carpet and furnishings; but when the ventilation is improved, so that it may be independent of outer atmospheric influences, and a continuous and greatly increased volume of entering air is obtained, we immediately are made aware of the amount of smut and dust which it carries along with it; and it was for the purpose of reducing this that I designed the system of combined air filtration and washing which has proved so beneficial, and is introduced with all installations of ventilation and air warming, and air cooling, carried out under my supervision.

The apparatus for the filtration and washing of the air consists of several thousand cords of suitable material, stretched from a beam near the ceiling to another near to the floor of the air chamber. When finished, the screen has the appearance of coarse cloth stretched across the apartment. The cords are placed so close that they touch each other, copper wires are laced through the vertical cords in horizontal rows, and, being drawn tight, give the screen a flat surface; the rough fibrous nature of the material breaks up the entering air into very minute streams, which pass through equally all over its surface.

These screens may be formed double, in order to give an extra cleansing or scrubbing surface when so desired.

The screen is kept moist by water trickling down each cord, and at regular intervals of more or less frequency, an automatic flushing tank discharges a considerable volume of water down the screen, to remove loose matter which may have collected, and to thoroughly wet the whole surface.

I shall briefly describe the benefits obtainable from the use of this screen for the removal of impurities.

The first impurity mentioned is—

Fog.

It is quite entitled to this position; not because of the frequent opportunity it affords of ample scope for the invention of legitimate additions to our vocabulary, but because it differs from any of the other impurities mentioned, in that we can see it, feel it, taste it, smell it.

The efficiency of the screen for the purification of the air from fog is most surprising. Not a particle of fog passes through the screen, and the air, immediately the screen is passed through, is bright and clear, perfectly sweet and free from odour; and, as expressed on a day of dense fog by Mr. A. Ernest Maylard, B.Sc., M.B., London:—"It might have been a bright, warm spring day, for all one could judge from the clearness and comfortable feeling of the atmosphere within."

It ought to be observed that, in the process of removing the abominations which combine to constitute a fog of the greatest density, my screen remains perfectly sweet and free from odour, requires no renewal or attention, the trickling moisture and the flushing do their work properly, and the screen is ready to filter ordinary air when fog has disappeared, as if there never had been any. This is important; for to pass into any building air for inhalation which had come into contact with the accumulations of germs and impurities removed from the fog, with their intensified hideous odour, ought to be considered a very insanitary operation.

The second impurity mentioned is—

Inorganic Matter in the Form of Smut and Dust Particlbs.

These are extremely difficult to entirely remove from the air, especially dust, and I do not pretend that it is possible to do so, except by such an expenditure for power to overcome the friction of drawing the air through many more filtering and washing surfaces as would render the effort too expensive, and beyond the possibility of its being adopted, except under very rare circumstances.

This we will readily comprehend when we understand that Mr. Aitken, of Falkirk, has, by the apparatus he has invented, been able to count the number of minute dust particles in a cubic inch of air, and he estimates that a cubic inch of our ordinary Glasgow city atmosphere contains 7,000,000 of these dust particles, while air tested near the top of mountains of great altitude contain 4,000 minute particles of dust to each cubic inch. And when I mention that the screens are constructed to deal with millions of cubic feet of air every hour continuously for years, you will not wonder we are content to remove the grosser particles of floating soot and dust, with as much as we can of the very minute particles. In passing the ordinary air of cities and towns through the filtering and washing screen, this is effected so thoroughly, that the purity of the air within the building is most marked. By my arrangements, the purest air is always found at the ceiling level, from which it steadily moves downwards to the nostrils; and, by analysis, the entering air at the level of the ceiling has been found to be practically free from organic matter.

An example of this fact may here be given:— A sample of air taken near to the air inlet to the Victoria Infirmary, Glasgow, required 4 volumes of oxygen to bleach the organic matter in 1,000,000 volumes of the air, while the following Table shows the condition of the air within the lower ward of that building at the same time:—

	Organic Matter.	Bacteria.	Moulds.
Lower Ward, 3 feet from floor	0	0	1
,, 6 ,, ,,	1·5	0	0
,, 9 ,, ,,	0	0	0
Outer Air	4·0	1	·5

The further purification of the air of apartments at the level of the occupants is effected in a manner so as to prevent dust from the feet, or from the carpet by the movement of the feet, emanations from the human body, or organic matter from the lungs, reaching the nostrils of those occupying the apartment, and is accomplished by directing the incoming air current towards the ceiling, where they are diffused. The rate of renewal of the air of the apartment may be from four to eight times per hour, or even more frequently as may be necessary. This volume, passing from ceiling to floor, maintains a constant downward movement of the whole air equally over the whole area, rapidly although imperceptibly, and positively without any draught being experienced anywhere. It will be observed that by this plan the fresh entering air reaches the nostrils before it has come into contact with the lower portions of the body, and in its passage outwards carries off with it, at the floor level, products of respiration and dust particles immediately these are generated. These apartments cannot be said to have any foul air within them; they are being swept clean continuously, and objectionable matter can neither enter nor accumulate within them. The openings for outlet being at the floor level, the pressure of the entering air dislodges the volume previously passing through the apartment, and permit of its easy removal. These provisions, with the aid of the filtering screen, keep the air very free from these impurities.

Filtered air, after the removal of fog, seems to the eye so much brighter and clearer than on other occasions, that I am inclined to say that if we could possibly artificially produce a condition of fog with all the entering air, the removal of the very minute dust particles would be very complete.

The third impurity—

Organic Matter in the form of Micro organisms.

I shall not enter on any question as to th extent of, or the danger to be apprehended from the presence of large quantities of bacteri in the air we breathe, and leave this to thos who may have made the subject a special study In considering the means for the purificatio of the air from these, I will restrict myself t giving a general comparative statement as t the condition of the air of schools for microbe under the three systems of ventilation whic have been already referred to. These are—

(1.) Natural ventilation by open windows, cowls, and fireplace flues.

(2.) Mechanical ventilation by extraction, the air being drawn through many openings in the outer walls, and warmed in passing up through coils of hot-water pipes at the window recesses.

(3.) Mechanical ventilation by impulsion, the air being drawn from one inlet only, warmed by the safe method of coming into contact with hot water or steam-heated tubes, the air not having been in contact with iron tubes highly heated directly over a furnace, and there being no pipes in any rooms or corridors, these being confined to the basement air-chamber.

1. *For school buildings ventilated by natural means.*—The analyses usually show the number of bacteria present in the air of class-rooms, on a level with the heads of the scholars, to range up to 50 to 60 per litre, or 1,556 per cubic foot of air.

2. *Mechanical ventilation for schools by extraction, or the upward method.*—The bacteria present range up to 54 to 82 per litre, or within 4 or 5 of 2,000 per cubic foot of air.

3. *Mechanical ventilation for schools by impulsion, or the downward method.*—The bacteria present at level of scholars' heads range up to 4 to 10 per litre, or 198 per cubic foot of air.

Permit me here to make a reference to the Victoria Infirmary, Glasgow, a building ventilated and warmed on the mechanical impulsion and downward system, and, from the inception of the idea to so ventilate it, till its completion, the whole arrangements were designed and carried out by me.

Mr. John Foggie conducted a series of exhaustive analyses of the air within this building towards the close of the year 1891, and the average number of bacteria found over the numerous tests were 0·22 per litre, whilst outside air, near to the Queen's-park, showed 0·3 per litre.

In his report he says:—"With regard to micro-organisms, the results show that, for any part of the wards, the number is exceedingly small. In fact, so incredible did these figures appear that it was decided to check them, and make certain that no mistake had been made. A further series of experiments were made, using Hesse tubes, and aspirating four times the amount of air taken in the first experiments. The figures for these are given below, and they confirm beyond question the results first obtained:—

MICRO-ORGANISMS IN FOUR LITRES OF AIR.

	Bacteria.	Moulds.	Total.
Ward I........	0	0	0
Ward II.	0	1	1
Ward III.......	3	2	5*

* Whilst No. 3 was being aspirated, the bed-covers in the immediate vicinity were changed.

A note is appended in explanation of the result of the last four litres aspirated, and marked with an asterisk.

The presence of the microbes under the accidental circumstances existing during the aspirating of the last four litres of air, when the bed-clothes were shaken up, illustrates a condition analysts invariably find, and is, that in proportion to the presence of dust in the air microbes are present in a similar ratio; and when schools have numerous air inlets at each floor level all round the building, it is impossible to prevent the wind driving dust from the play-ground into them.

Against the introduction of this statement, using it in comparison with the air of schools, it may be asserted that a hospital is not so fully occupied, nor has any relation to a school; but we must bear in remembrance that a school is generally occupied only five hours each day, and that for only five days in the week, whereas a hospital is occupied every hour of each day and night for seven days each week, or 168 hours, against the school's 25 hours per week, without taking into consideration the usual relief given to schools by holidays at midsummer and Christmas.

Mr. Maylard, senior surgeon for this hospital, has on several occasions referred to the remarkable success attending operations on patients, mentioning the purity of the air.

A digression from the subject of purification of air may here be permitted to show the importance of purity of water also, by saying that more recently I have been informed by Dr. Gibson, the medical superintendent, that Mr. Maylard has on several occasions analysed the hot water used throughout the hospital, the examination being conducted to discover whether any microbes could be found in it, and he has not been able to discover one. The purity of the hot water, no doubt, assists in the healing of wounds, as it is freely used for bathing, fomentation, poulticing, &c. The water is steam-heated, but without coming into actual contact with steam, my object in designing the arrangement being that hot

water be always obtainable, day and night, and be drawn off instantly at boiling temperature on any floor level.

Carbonic Acid.

In the *brochure*, entitled "The Problem of School Ventilation," of which Mr. Thomas Hector, Clerk to the School Board of Aberdeen, and President of the School Board Clerks' Association, is the author, he refers to the proposition laid down by the late Professor Carnelly, viz. :—"That whereas the quantity of carbonic acid is usually taken as a measure of the total impurities of air vitiated by breathing, it is highly improbable that an increase in the carbonic acid and a slight diminution in oxygen materially affect the death-rate; but that the presence of organic matter and micro-organisms in the air are in all probability far more important factors."

By the mechanical and impulsion or downward system of ventilation, using hot water or steam-heated tubes for warming the entering air, this impurity in school class-rooms is reduced to one-half to three-fifths of that usually found in naturally ventilated and mechanically ventilated schools by the extraction system.

In his report on the condition of the air within the Victoria Infirmary, for carbonic acid, Mr. Foggie says:—"A glance at the figures for temperature and carbonic acid shows that the patients were enjoying a constant supply of warm fresh air, which, even at its worst, was only two volumes of carbonic acid per 10,000 in excess of that present in the air outside of the building." And, further, in evidence of the purity of the air within the ward, 9 feet from above the floor level and 7 feet from the ceiling, I may further quote from the report, which says:—"In the centre of the wards the average for carbonic acid was slightly higher than near the patients; the samples for these were collected at 3 feet, 6 feet, and 9 feet from the floor respectively, the figures at this latter position being 4·8 volumes carbonic acid per 10,000, or only 0·3 volumes in excess over outside air at the time."

When lighting by gas is resorted to, the volume of deleterious products of combustion given off to the air are so infinitesimal as compared with the volume of the entering air as to be scarcely ascertainable in parts of 10,000, the air of the apartment remaining perfectly pure, the heating apparatus requiring only slight modification when the numerous gas jets have been lighted.

Under ordinary circumstances, when an apartment is well ventilated by the downward system, although fully occupied, the temperature of the out-going air, when carrying off the added warmth given to it by contact with the human body, seldom shows an excess over the inlet temperature of 2° Fahr.

These figures refer to school-rooms when from 70 to 100 pupils may be present, and they show us something novel resulting from the methods I adopt for the ventilation of these apartments, and directly opposed to all recognised rules for guidance of engineers in the preparation of designs for the ventilating of buildings. Hitherto the popular belief has been that we should adopt a system which should seem most natural, claiming that the heated air, from contact with the human body and exhalations from the lungs, being so much warmer, and hence lighter, than the ordinary air in rooms, ascends to the ceiling, and w should assist this by employing means for carrying these off at the higher levels near the ceilings. But let me impress upon you that these arguments do not hold good when an effective system of ventilation is adopted, and the air of an apartment is renewed sufficiently often. These volumes of heated air and exhalations from the persons and lungs of those present are but a small per-centage of the volume of entering air. The entering air immediately cools these exhalations to the same temperature, and at equal temperature with fresh air these noxious products of respiration are heavier than the entering air, and materially assist the downward system of ventilation. One of the evils of upward ventilation is that dust rises from the floor to be inhaled by those present.

When a sufficient volume of air is impelled into a room, to renew it frequently per hour, then the expense for heating becomes excessive, as the warm air rises directly to the ceiling, requiring much more fuel to maintain a given temperature than when the warmed air must pass off at the floor level.

By the upward or vacuum method, noxious gases and air from undesirable quarters are drawn in, such as sewer gas from faulty soil pipes, and not least, emanations and dust from the bodies and clothes must pass the nostrils, to be inhaled as they pass upward, rendering the congregating of many persons in public places of resort a source of danger, when epidemics of infectious diseases are prevalent; whereas, by the downward system, the nostrils receive fresh air from direction of the

:eiling, and dust and emanations pass downwards, thus lessening the chances of inhaling ıoxious gases.

The next conditions of the air of interiors I ıave mentioned are—

Moistness and Dryness.

The presence in the air of moisture in excess luring warm weather produces langour and assitude, both of mind and body; dryness of he air bringing about a difficulty in breathing, vith sore throat. Both of these unwholesome :onditions are entirely prevented by the use of ny screen :—Air, which in summer or sultry veather may be saturated with moisture, has he excess condensed out while passing hrough the wet filtering and washing screen, ınd is passed inward, containing only sufficient noisture for a natural and easy respiration.

Dryness.

In winter, during severe frosty weather, the ir becomes very dry and unpleasant for respiation, and this is avoided by passing through : the wet screen. Our arrangements for preenting the screen from freezing in winter omprise the placing a steam or hot-water oil between it and the entering air. The :mperature of the air, while passing through ıe screen, can be raised to any desired egree, and the screen surface, being at a igher temperature than the outer dry air, ıoisture is taken up by the air while passing ırough, giving to the air entering the buildıg a natural humidity, and rendering the air leasant for easy respiration. By these means ıe condition of the air for moisture can be ept uniform summer and winter.

The last subject of discomfort to be removed om the air of the buildings on my list is the 'er present one of

Draughts.

By the natural, or upward system of ventition, it is scarcely possible to avoid them. ıould you be able to sit anywhere in apartents so ventilated without experiencing a 'aught, you may be sure that there is either very tle ventilation of any sort, or an accident has curred in the construction of the room which ose who designed it will not be able to apply any other.

If you sit between the door and the fireıce; between the window and the fireplace; tween the door and the window; under a ›sed window while the air outside is cold, or ıile the window may be open; or under a ceiling ventilator when the fire is burning brightly, you experience draughts almost everywhere — aye, even in the pews in the centre of churches, where cold air comes down, warm air dislodging it by escaping from under the galleries, and ascending roofwards.

Draughts exist in the upper levels of every room ventilated mechanically by extraction, while the halls of such buildings are generally full of draughts. There are many influences at work to create draughts, but the sum of the whole is, that they are caused by faulty methods of ventilation.

Draughts can be entirely removed from interiors of buildings by the proper application to them of the downward system of ventilation, and be rendered quite destitute of such a draught.

By no other system that I know of can draughts be so thoroughly avoided; and when air is properly tempered in the heating chamber, which it can easily be, the impulsion system fills every apartment with a uniform temperature of air; every part of a room is of the same temperature; persons of all ages are equally satisfied, none feeling too hot nor too cold — the equableness of the air of every apartment being a very special feature.

I may mention that recently I have had the experience of investigating into the reasons for unequal temperatures within large drying stoves for cotton yarn; the whole surfaces of the floors were all equally perforated for the passage of the heated air upwards, yet some yarn was dried too hard for spinning, others partially dried, and the remainder quite wet. Had these yarns been individuals within these large chambers, the condition of the yarns enables us to conjecture what the numerous and different opinions as to the ventilation of the apartment would have been —cold draughts, hot draughts, air too hot and too cold. The highly heated air currents rising with greater velocity to the roof ventilators at one portion than another kept the lead; cold down currents passing inwards to keep up the circulation, and, by the arrangement of perforating the whole area of a floor, no other result could be expected. My provision for equal drying and removing of moisture is by our improved downward system, using a wet screen for removing moisture and returning the heated air, for drying naturally and equally by air volumes, with as little loss of heat as possible—the floor and ceiling being made quite air-tight.

I have said that chemists have furnished us with the means of correctly ascertaining the condition of the air within our buildings. We cannot appreciate their work too highly. Chemists ought to be much more generally engaged in the work of making analyses of the air of public buildings than they are at present; and, permit me to add, that there would be no office of more public and national importance for the preservation of life and of those of tender years attending our public schools, and for the prevention of the spread of epidemics, than would result from the appointment of an efficient public analyst, whose duties would be to regularly perform research work in connection with the air of schools, public buildings, and of towns, at every season of the year continuously, and report monthly the results of examinations. We could then, and only then, have a foreknowledge of where we might expect any infectious disease to spread rapidly. Ventilating and sanitary engineers would be thus enabled to use the knowledge given them by the analysts for the application of means for the prevention of the evil.

DISCUSSION.

The CHAIRMAN said they were much indebted to Mr. Key for his interesting and suggestive paper. With regard to the question of employing the number of micro-organisms in the air as a means of judging of its purity, he might say that both Professors Carnelly and Haldane pointed out the very great difficulty there was in relying upon that test. If a room were left in a quiescent condition, the number of these organisms found in the air might be very small, but the shaking of a carpet or a mat, or movement of bed-clothes, had a tendency to fill the air temporarily with a large number of them. The paper, however, was mainly directed to the question of downward ventilation, as compared with upward; and he would point out that Mr. Key's suggestion for admitting fresh air into a room, at a level above the heads of the occupants, and removing the air by openings at or near the floor level, was not new: it was the system proposed by Mr. Sylvester, by Sir Joshua Jebb, and by General Morin. But in those instances the movement of the air was caused by an extraction shaft, into which all the extraction flues were led. At Paris, however, as far back as 1850, MM. Thomas and Laurent ventilated the Laribaissiere Hospital, and Dr. Van Heecke ventilated the Hospitals Beaujon and Necker, by propulsion. In their system the air entered the wards through pedestals about five feet high, placed in the central part of the walls; and the air left the wards through openings placed at the floor level, which led into flues in the walls, which were carried up to above the roof of the building. That was very much the system adopted in the Victoria Infirmary. The Hospital Teuon. at Paris, the Barnes Hospital, at Washington, and the New York Hospital were all ventilated by propulsion, connected, in some cases, with forced extraction. The novelty of Mr. Key's method lay in the purification of the air, which is admitted by passing it through a wet screen. When London air is passed through a cotton wool filter, the filter is very soon clogged with dirt, and must be renewed at short intervals. The ingenuity of the system devised by Mr. Key was that it enabled the screen to be automatically cleansed at short intervals, and this enables it to go on continually cleansing the air. When in Scotland last year, he took the opportunity of examining Mr. Key's apparatus at the Victoria Hospital, Glasgow, and learned from the medical men and nurses that the air pumped in was always clear and bright, and that on days in winter, when the outside air was full of fogs the wards were free. In London there was a building where this method of purifying air might be applied with very great advantage, and that was the House of Commons. There there was a system of washing the air by means of spray, and filtering it through cotton wool, but this soon got clogged, as he had just remarked. But if Mr. Key's arrangement were adopted, it would not have justice done to it unless the whole system of ventilation were reversed, and the air were introduced at the upper part and drawn down through the floor. The present plan was most illogical. The air was purified by complicated and expensive arrangements, and was then admitted through a perforated floor, upon which the members deposited the manure and dirt they had gathered on their boots, and then they breathed this re-polluted air, and complained of lassitude after a certain time.

Mr. W. LORIMER said Mr. Key had so fully explained the nature of the system, that he would pass from that part of the subject, and deal with it from the point of view of practical experience, which, as Chairman of the House Committee of the Infirmary, he was in a position to do. The professional staff were delighted with the results, and considered the system as near perfection as could be hoped for. The surgeons said the curative process, even in the case of severe injuries, was accelerated by the patients breathing pure air at a practically unvarying temperature, and the testimony of the physicians was equally emphatic. The windows in the wards were made to open, but in fact there was no need to open them, and all could understand how valuable it was, both for patient and physician, that this need not be done in the case of patients suffering from puenmonia, especially in severe and foggy weather. One very important point was, that in times of emergency, the accommodation was practically increased by 15 per cent. During the last few weeks the pressure had been very great, and at the

present moment the wards were so full that, if they had to depend on natural ventilation, they would be gravely overcrowded. He had brought with him a number of temperature cards, a few of which he would read. The temperature was recorded once in the daytime, at 10 a.m., and five times in the night, at 10, 12, 2, 4, and 6. On January 23rd the day temperature was 62°, in No. 1 ward, and it was the same all through the night. In No. 2 ward it was 64° in the day, and the same at night on each occasion. In No. 3 ward it was 62° in the day, and at 10 and 12 at night; and at 2, 4, and 6 a.m., 61°. The night before he left Glasgow the results were practically the same. On January 6th, which was a very cold day, the maximum temperature in Queen's-park, adjoining the infirmary, was 21°, and the minimum 10°; the temperature in the three wards was 64°, 64°, and 63°. On August 5th last, a very hot day, the maximum shade temperature in the park was 74°, and the minimum 46°; in the wards it was 65° and 66°. The original plans of the infirmary were prepared with a view to natural ventilation, and it was only after the foundation and part of the superstructure had been erected that it was decided to adopt the present plan. The change was made after much consideration, and the results were looked forward to with some anxiety; but they were now completing an additional pavilion, which would double the accommodation, and in devising the arrangements for its ventilation, there was not a moment's hesitation about continuing the present system. It was not possible to speak as specifically as he should have liked on the important question of cost, because steam was used, not only to drive the dynamos which operated the fans, but also to heat the coils and provide hot water all over the building, and to drive a duplex pump and the machinery of the laundry. Besides that, the machinery was practically duplicated, both to provide for emergencies, and for the additional call upon it when the hospital was enlarged. The total cost last year for wages, fuel, and ordinary repairs, but not depreciation, was £650; and assuming, which he thought was a liberal assumption, that 30 per cent. of that was applicable to the heating and ventilation, that gave £200 for a hospital containing 80 or 90 beds; and very little more would be required to heat and ventilate a building accomodating 150 or 160. No doubt £200 was considerably more than would be required to heat and ventilate, by open fires and windows; but there were economies in other directions; the wards did not require nearly so much cleaning, and he believed the system was economical, on the whole, if by economy you meant the best and most successful method of achieving the purposes for which the hospital existed. If it could be shown that, as a consequence of this system, the average residence of patients was reduced by only one day—and he believed that much more than that would be shown when the statistics could be obtained—the whole excess of cost was at once swept away.

Mr. H. C. Burdett said he was very much interested in the question of hospitals, and especially in their ventilation, but he believed that evidence had not yet been adduced to prove that, in a climate like this, artificial ventilation was necessary. He had been to Glasgow, and inspected the Victoria Infirmary, and also the Municipal Buildings, which might be called a municipal palace, so splendid were they; and if the system of ventilation here adopted could be applied to the infirmary, it would not be open to the objections which he had to make. The infirmary was one of the most recent, and, architecturally considered, one of the most complete buildings of its kind; and he did not think any artificial ventilation was really neeessary for it. When he examined the system there employed, he found two grave defects in it. First of all, it was evident, from the condition of the walls and ceilings, that a great amount of impurity was introduced with the air coming through the ducts. In the Municipal buildings greater care was taken with regard to the purification of the air introduced. In the Infirmary there was purification at the main duct, but not in the smaller ducts which conveyed the air to the wards, and on putting your hand into these ducts you found them coated with dust and other impurities. This might be considered a minor defect, but it was one of some importance. Each of these ducts ought to be provided with a cleansing mouthpiece, or respirator, to remove the impurities generated in the main duct. Again, according to his experience, though the air of the larger wards was satisfactory, that of the smaller wards was not, it was more unsatisfactory than that of almost any wards he had examined. He was told that when the arrangements for ventilating the smaller wards were introduced, the necessary requirements had not been adequately realised, and that in the new additions now being made, these defects would be remedied. If anything, greater attention should be paid to the necessities of the smaller wards, because it often happened that the worst cases were placed in them. It was only right to say that, when he visited the infirmary, Dr. Mackintosh was no longer in charge. He did not know him personally, but he had the greatest respect for his work, and he was informed that the defects to which he referred were not apparent under his management. It might be that some re-arrangements had been made, and things had not settled down. But there were certain dangers attaching to all systems of artificial ventilation. Years ago he went to see the Antwerp hospital, the first of a large size built on the circular ward plan. When he first visited it, it was not occupied, but he went with the engineers and architect, and saw the whole system of ventilation, which was carried out in the most complete manner. Two years afterwards, when he went again, he found the atmosphere of every ward perceptibly thick. It was under the charge—as many continental hospitals were—of a sisterhood, and he was told they had a prejudice against adequate venti-

lation, and the consequence was the system of artificial ventilation was throttled, and not allowed to operate. In 1891, he went over a number of hospitals in the United States, some of which had artificial ventilation and some had not, and he found that the latter were in a better condition than the former. He might instance two institutions built under the direction of one of the ablest men of the day, Dr. Billings, of Washington. One was the hospital for old soldiers, near Washington, where the system was very similar to that at the Victoria Infirmary, though there was one important omission—there was no provision for purifying the air. Both Dr. Billings, who went with him, and himself were very dissatisfied with the condition of the atmosphere, and they went down to examine the apparatus. They then found that, about 18 months before, the superintendent had been changed, the new man had a prejudice against artificial ventilation, the fire had not been lighted for months, and the fan was covered with cobwebs. Another hospital, one of the finest in the world, was the Johns Hopkins Hospital, at Baltimore, the plans of which took so long to prepare, in order to have everything thoroughly complete, that the interest on the money left for it was sufficient to pay for the whole building without touching the capital. He went over that also with Dr. Billings, who was both architect and medical superintendent. In the rectangular wards the atmosphere, temperature, and everything was perfect; but in the octagonal wards it was so thick that he felt as if he could write a pattern in it. On examination, it was found that the control of the valves in the octagonal wards was left in the hands of the nurses, but those of the rectangular wards were locked up, and were in the sole eontrol of the officer in charge of the ventilation. In the one case the system had fair play, and in the other it had not. When the ventilators were opened, the one ward became as satisfactory as the other. If, therefore, you could do without artificial ventilation it was much better, because of the gross stupidity of those who had it in charge; but it it were employed, notwithstanding the criticisms he had made, he did not think a cheaper or more efficient system than that adopted at the Victoria Infirmary could be expected.

Mr. WILLIAM WHITE thought the system described by Mr. Key was by far the best yet brought forward, and the objections of the last speaker were rather to the abuse than the use of artificial ventilation. For many years he had advocated the downward system, and, in spite of much opposition, was more and more in favour of it. Thirty years ago, he ventilated a church without artificial draughts and ducts. by building a tunnel five or six feet square, with a channel from the middle of the church into it; and, as far as he had heard, there had been no complaints since. The admission of cold air at the top of a room could not take place without draughts, except by means of some mode of distribution; and he had heard an invention described in that room as being very efficient for introducing jets of air through small tubes. The difficulty of downward ventilation, however, without some mechanical power, was very great, but it might possibly be carried out by means of a large extractor flue, with heat at the bottom of it, not at the top, as was sometimes tried and always failed, because warm air at the top would not draw cold air after it. He thought that the evidence was rather to show that the micro-organisms were raised by dust, and not by the motion of the air without dust.

Mr. BAYLEY MARSHALL said he had been much interested in the installation at the Victoria Infirmary, and, as an independent engineer, had made a very careful examination of it on more than one occasion. He could endorse everything Mr. Lorimer had said as to its merits, and differed very much from Mr. Burdett's views and statements. He had placed his handkerchief in one of the ducts, and on removing it after some time, found it as white as when he put it in. As long as the system had fair play it was all right, and he thought there must have been something accidently wrong on the occasion of Mr. Burdett's visit. After an examination extending over six months, he was so convinced that this was the right system, that he had got it adopted for a large new hospital which was being erected in Birmingham, at a cost of £200,000, to hold 400 beds. The easy regulation of the temperature was a most important point, especially in the case of patients with chest complaints. In an ordinary hospital there was considerable danger often in giving baths to such patients, as they got chilled on coming out, but this system was so perfectly under control that you could bring the temperature of the bath-room up to nearly 100° when the patient came out of the bath, and then gradually lower it to the temperature of the ward, so that he went back to his bed without having appreciated any change of temperature. It frequently happened that a patient in great pain would just drop off to sleep, and then be awakened by the nurse poking the fire, when his rest would be destroyed for the remainder of the night, but with this system there were no fires to poke. Cleanliness again was very important in a hospital, but these wards hardly ever required cleaning. If this system were adopted in schools, there was no doubt the children would be healthier and grow better. The essential feature of it was that it did not seek to coax out the foul air, but sent in a large quantity of pure air, and the foul air was forced out; there was no help for it.

Mr. NESBIT said the scheme propounded by Mr. Key was not new, and he had advocated a similar method for many years, which was much the same as that introduced by the late Mr. Phipson. The water screen might be beneficial in some respects, but he thought it might over-moisten the air. He had

ventilated a lunatic asylum in the midland counties, and, according to the testimony of the medical officer, even the small rooms about ten feet by six feet, in which some patients were locked at night, were found to be quite fresh in the morning.

The CHAIRMAN having proposed a vote of thanks to Mr. Key, which was carried unanimously,

Mr. KEY, in reply, said if he were to repeat what had been said about the excellent ventilation of the municipal buildings to the citizens of Glasgow, he should be received with a roar of laughter. For the last four years they had been trying all sorts of things, and spending an immense deal of money, in trying to improve the ventilation. Many of the ceiling beams had the dry rot, and had to be taken out and replaced, because of the want of ventilation, and so stagnant was the air that where the warm air was designed to come in, the cold air went out, and what fresh air did get in, came in through what were meant for the outlets. The head of one of the departments told him that he could not keep a single document lying on his table on account of the dust. He admitted the discoloration of the walls of the infirmary, but that could easily be explained. The small wards, for some time before Dr. Macintosh left, had been almost entirely cut off from the ventilating apparatus, owing to structural alterations for connecting the new buildings with the old; and when the new building was completed, all that would be remedied. The discoloration of the walls had been there ever since six months after the building was opened, and was occasioned by defects in the plumbers' work leading to leaks of the water supply, and the whole place had to be explored with what were called "goose lamps," which gave off a great quantity of smoke and blacks, and this got on to the walls. Wherever the walls had been recoloured there was no sign of discoloration. The municipal buildings were wonderfully clean; there was no sign of dust at all, which he took to be a sign that very little air got into it. He had already explained that his apparatus did not remove the fine suspended dust particles, and if you had two million cubic feet of air forced into a building every day in the year, you must expect some darkening of the walls. As yet there had not been an opportunity to clean the wards or recolour the walls, and they had been able to do without it. It was utterly impracticable to put a screen at each inlet of air into such a building. Either it would prevent the ingress of air which was wanted, or so much force would be required to drive it through, that the expense would be prohibitive. He had had the air of a school where such screens were provided analysed, and although it had only been occupied a very short time, it was the worst of any he had examined. It was a great mistake to suppose that the screen would make the air too moist. Dr. Mackintosh, of whom it was impossible to speak too highly, during both winter and summer had both dry and wet thermometers placed in various positions, and he proved that in winter, when the air was dry outside it was humidified inside; and in summer, when it was supersaturated outside, it became dried in passing through the screen. He had not visited the infirmary very recently, and possibly there might have been some neglect which formed a foundation for Mr. Burdett's remarks, and he would take an early opportunity of investigating the matter. The Birmingham Committee were very careful in their investigations before adopting the system. The number of rooms to be ventilated there would be about 600; and 18,000,000 cubic feet of air every hour, or 432,000,000 every day, would be impelled into the building.

Miscellaneous.

COMPOSITE HELIOCHROMY.

A Special Committee, appointed by the Photographic Society of Philadelphia, in September last, have reported on Mr. Frederic E. Ives's work as follows:—

"Your committee, appointed 'to take into consideration the advisability of some form of recognition by the Society of Mr. Ives' work in connection with Composite Heliochromy,' have given the subject very full and careful consideration, and they respectfully report that in their opinion the work of Frederic E. Ives is worthy of the highest form of recognition which the Photographic Society of Philadelphia can give.

"Before entering into any description of what Mr. Ives has done, your committee deem it wise they should in their report clear the ground of any misapprehensions which might arise from the terms used in dealing with the subject. Mr. Ives' process is not the kind of colour photography for which the world has been looking, and may never find, nor is it 'photography in natural colours' in the sense in which those terms are commonly understood. In a technical and scientific sense, "natural colours" are those which are produced in any substance by the direct effect of light itself, acting in accordance with the laws of nature. Mr. Ives has, nevertheless, realised one solution of the problem, and the colours which are reproduced from nature by his process are as correct as are ordinary photographs in rendering in monochrome the effects of light and shade. In other words, 'Composite Heliochromy,' being a purely photographic process, is subject to the same limitations which circumscribe photography. When a process of photography is perfected which will avoid the defect of flattening the high lights when a sufficient exposure is given to bring out detail in the

shadows, and the defect of undue increase of contrast in the middle shades, then the results of composite heliochromy will be perfected ln like degree."

Mr. Ives's system of composite heliochromy is then described. [See Mr. Ives's paper in this *Journal*, vol. xl., p. 687.]

Mr. Ives claims that his various improvements have—

"1. Solved the problem of reproducing the natural colours by photography.

"2. Simplified the procedure so much as to make it possible for any good photographic operator to make the photographs, when supplied with the special camera, even if he have no knowledge whatever of colour science.

"It appears to this committee that Mr. Ives' claims are sustained, not only by argument and references, but also by his exhibition of results, which may fairly be said to be wonderful improvements upon anything obtained by his predecessors. In fact, while the results obtained by Du Hauron and others are described as crude and unsatisfactory, Mr. Ives shows, by his process in the Heliochromoscope, reproductions so perfect that is it sometimes difficult to realise that one is not looking at a reflection of the object itself, instead of a photograph."

The committee recommended the following resolutions, which were adopted by the Society on December 14th last:—

"Whereas, Frederic E. Ives, of Philadelphia, has, by the application of his new principle in composite heliochromy (dating from November 21st, 1888), made a practical solution of the problem of recording and reprodncing by photographic means the colours of nature; and whereas, Mr. Ives has, not only in this connection but in many other ways, notably in the field of photo-mechanical printing processes, orthochromatic photography, and optical projection, made distinguished contributions to the progress of the art and science of photography; and whereas, the Photographic Society of Philadelphia is incorporated for the special object of increasing and diffusing 'the knowledge of those natural laws which relate to the action of light, and particularly to promote improvements in the art of photography;' it is therefore resolved, that as a special recognition of the eminent scientific labours of Frederic E. Ives, a gold medal is hereby awarded to him by the Photographic Society of Philadelphia."

CHICAGO EXHIBITION.

The following Ode on the Chicago Exhibition has been written by Mr. Swinburne, and set to music by Professor Stanford:—

East to West.

I.

Sunset smiles on sunrise: east and west are one,
Face to face in heaven before the sovereign sun.
From the springs of the dawn everlasting a glory renews and transfigures the west.
From the depths of the sunset a light as of morning enkindles the broad sea's breast.
And the lands and the skies and the waters are glad of the day's and the night's work done.

II.

Child of dawn, and regent on the world-wide sea,
England smiles on Europe, fair as dawn and free.
Not the waters that gird her are purer, nor mightier the winds that her waters know.
But America, daughter and sister of England, is praised of them, far as they flow:
Atlantic responds to Pacific the praise of her days that have been and shall be.

III.

So from England westward let the watchword fly,
So for England eastward let the seas reply;
Praise, honour, and love everlasting be sent on the wind's wings, westward and east,
That the pride of the past and the pride of the future may mingle as friends at feast,
And the sons of the lords of the world-wide seas be one till the world's life die.

Obituary.

Colonel George Edward Grover, R.E.—Colonel Grover, whose sudden and unexpected death at Chicago, on the 29th January, was announced in the newspapers of Monday last, had been in the service of the Royal Commission since April, 1892, when he went out to America to take special charge of the erection of Victoria House, the head-quarters of the Royal Commission at Chicago. From that time Colonel Grover acted as the representative of the Royal Commission continuously (with the exception of the time occupied by his return to Europe last summer), up to the present date. His services throughout were most efficient, and the interruption of the work of the Commission, caused by his untimely death, will certainly be productive of considerable inconvenience. Colonel Grover was born in 1840, and entered the Army in 1858. He served in Canada in 1866; in Nova Scotia in 1874; and (on special duty) in Turkey and Roumania in 1876-7. In the Soudan Expedition of 1885 he was attached to head-quarters as Deputy-Assistant-Adjutant and Quartermaster-General of the Intelligence branch. He was present at the reconnaisance of Hasheen, and the action at the

same place a few days later; also at the operations near Tamai. He was mentioned in despatches by Lord Wolseley and Lieut.-General Sir G. Graham. He also held various appointments at home, including that of Superintendent Engineer at Portsmouth Dockyard, under the Admiralty, which department expressed their satisfaction at the ability and zeal in which he (then Major Grover) discharged his important duties. The estimation in which Colonel Grover was held was also shown by the fact that he was twice selected for employment at head-quarters, including the appointment of Assistant-Inspector-General of Fortifications in the Barrack branch. He was on the Executive Committee of the International Exhibitions held at South Kensington from 1871 to 1874. Sir Henry Cole was chairman of the committee, and the other members were Lieutenants Clayton and J. H. Cole. He took charge of the machinery and scientific collections, and was senior member of the committee. From February, 1880, to February, 1881, he acted as Secretary to the Royal Engineers' Committee, and was a member of the inter-departmental committee on British cemeteries abroad, in which capacity he produced an important report on that subject. Besides being a Member of the Society of Arts, he was an Associate of the Institution of Civil Engineers, and a fellow or member of several other learned societies.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

FEBRUARY 8.—PROFESSOR W. NOEL HARTLEY, F.R.S., "On some Points in the Chemical Technology of Oil Boiling, with an account of a New Process for Preparing Drying Oils, for Decorators' and Artists' use." PROF. J. M. THOMSON will preside,

FEBRUARY 15.—PROF. FRANK CLOWES, D.Sc., "The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air." SIR FREDERICK ABEL, K.C.B., F.R.S., will preside.

INDIAN SECTION.

Thursday afternoons :—

FEBRUARY 16.—Sir WILLIAM WILSON HUNTER, K.C.S.I., C.I.E., LL.D., "The Progress of India under the Crown." The MARQUIS OF RIPON, K.G., G.C.S.I., C.I.E., will preside.

*** This meeting will take place at 3 p.m. instead of 4.30 p.m.

MARCH 9.—JERVOISE ATHELSTANE BAINES, C.S. (Bombay), "Caste and Occupation at the last Census of India." The LORD REAY, G.C.S.I., C.I.E., will preside.

APRIL 6.—The Hon. Sir EDWARD N. COVENTRY BRADDON, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisation."

APRIL 27.—Sir JULAND DANVERS, K.C.S.I., "Indian Manufactures." Sir ALEXANDER WILSON, formerly President of the Bengal Chamber of Commerce, will preside.

MAY 11.—Sir RAYMOND WEST, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results."

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock :—

FEBRUARY 28. — SIR EDWARD BRADDON, K.C.M.G., "Russia as a Field for Tourists."

MARCH 21.—CECIL FANE, "Newfoundland."

APRIL 18.—H. A. MCPHERSON, "The Philippine Islands."

MAY 2.—E. DELMAR MORGAN, "Russian Industrial Art."

MAY 18.—W. B. PERCIVAL, Agent-General for New Zealand, "New Zealand."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock :—

FEBRUARY 7.—WILTON P. RIX, "Pottery Glazes: their Classification and Decorative Value in Ceramic Design." Sir HENRY DOULTON will preside.

FEBRUARY 21.—T. R. SPENCE, "Wall-papers and Stencilling." LEWIS F. DAY will preside.

APRIL 11.—PROF. PAUL SCHULZE, "History and Development of Pattern Designing in Textiles." THOMAS WARDLE will preside.

MAY 9.—W. M. FLINDERS PETRIE, "Primitive Art in Egypt." EDWARD J. POYNTER, R.A., wil preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

PROF. J. A. FLEMING, M.A., D.Sc., F.R.S., "The Practical Measurement of Alternating Electric Currents." Four Lectures.

LECTURE II.—FEBRUARY 6.—*The Measurement of Alternating Current Potential.*—Definitions of inductance and impedance—Laws of current flow in inductive circuits—Construction of non inductive resistances—Electrostatic and electrodynamic voltmeters—Voltmeters of Kelvin, Ayrton, Swinburne, Cardew, Siemens, Elihu Thomson, Evershed, Nalder, and others—Alternate current potentiometer—Employment of electrostatic voltmeters and non-inductive resistances for current measurements—Standardisation of high-tension voltmeters—Measurement of capacity of condensers and concentric cables—Capacity effects in cables and condensers.

HOWARD LECTURES.

Friday Evenings, at Eight o'clock :—

Prof. W. Cawthorne Unwin, F.R.S., "The Development and Transmission of Power from Central Stations."

Lecture V.—February 10.—Transmission of power by compressed air — History of the Paris scheme—Action of compressor main and motor—Reasons of low efficiency—The new Paris station—Advantages of compressed air—Applicability to long-distance transmission—Distribution of power by gas, by steam, and by superheated water.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 6 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. J. A. Fleming, "The Practical Measurement of Alternating Electric Currents." (Lecture II.)

Engineers, Westminster Town-hall, S.W., 7½ p.m. Inaugural Address, by the President, Mr. W. A. M. Valon.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. Oscar Guttmann, "Manufacture of Nitric Acid." 2. Mr. R. Warrington, "The Detection and Estimation of Lead in Citric and Tartaric Acids." 3. "A New Form of Laboratory Filter Press," exhibited by Mr. C. C. Hutchinson.

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on papers by (1) Mr. P. D. Tuckett, "A Short Explanation of the Proposed Bi-metallism as affecting British Interests;" (2) Mr. A. Goddard, "The Currency Question and Land."

Medical, 11, Chandos street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Mr. J. M. Mello, "Primitive Man."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. J. J. Harris Teale, "The Natural History of Silica."

Tuesday, Feb. 7 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p m. (Applied Art Section.) Mr. Wilton P. Rix, "Pottery Glazes: Their Classification and Decorative Value in Ceramic Design."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "On the Functions of the Cerebellum and the Elementary Principles of Psycho-Physiology."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Papers by (1) Mr. Henry F. Collins, "Smelting Processes for the Extraction of Silver and Gold from their Ores;" (2) Mr. James W. Malcolmson, "The Erection of Silver-Lead Smelting Works in Mexico."

Pathological, 20, Hanover-square, W., 8½ p.m.

Sanitary Institute, Parkes' Museum, Margaret-street, W., 8 p.m. Mr. H. Law, "Principles of Calculating Areas, Cubic Space, &c.; Interpretation of Plans and Sections to Scale."

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Wednesday, Feb. 8...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. W. Noel Hartley, "Some Points in the Chemical Technology of Oil Boiling, with an account of a New Process for Preparing Drying Oils, for Decorators' and Artists' use."

Geological, Burlington-house, W., 8 p.m.

Sanitary Institute, Parke's Museum, Margaret-street, W., 8 p.m. Dr. G. V. Poore, "Light, Air, and Fog."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

Entomological, 11, Chandos-street, W., 7 p.m. 1. Mr. Roland Trimen, "Some new, or imperfectly known, species of South African Butterflies. 2. Mr. T. D. A. Cockerell, "Two new species of *Pulvinaria* from Jamaica." 3. Mr. Martin Jacoby "Descriptions of some new genera and new species of Halticidæ."

Patent Agents, 63, Chancery-lane, W.C., 7½ p.m. 1. Discussion on Mr. Hardingham's Paper "Adumbration of Inventions." 2. Mr. A. Melville Clark, "A Difference of Opinion, or the True and First Inventor." 3. Mr. A. Woosnam, "Concurrent Patents for the Same Invention."

Thursday, Feb. 9 ... National Association for Promoting Technical and Secondary Education (at the House of the Society of Arts), 1½ p.m. Conference under presidency of the Duke of Devonshire.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Dr. A. C. Mackenzie, "The Overture." (With Illustrations.)

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Patrick Geddes, "The Factors of Organic Evolution."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. 1. Prof. Fleming's Reply to Discussion on his paper, on "Alternating Currents." 2 Mr. W. M. Mordey, "Notes on Testing Alternators."

Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, Feb. 10 ... SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. (Howard Lectures.) Prof. Cawthorne Unwin, "The Development and Transmission of Power from Central Stations." (Lecture V.)

United Service Institute, Whitehall-yard, 3 p.m. Colonel . Keyser, "The Different Systems of Signalling in the Field."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Charles Stewart "Some Associated Organisms."

Civil Engineers, 25, Great George-street S.W. 7½ p.m. (Students Meeting) Mr. H. Calder Lobnitz, "Long Shoot Dredgers: their Design and Mode of Working."

Astronomical, Burlington-house, W., 3 p m. Annual Meeting.

Junior Engineering Society, Westminster Palace Hotel, Victoria-street, S.W., 8 p.m. Messrs D. T. and A. C. Heap, "The application of Small-power Electric Motors."

Clinical, 20, Hanover-square, W., 8½ p.m.

Sanitary Institute, Margaret-street, W., 8 p.m. Mr W. C. Tyndale, "House Drainage."

Physical, Science Schools, South Kensington, S.W. 5 p.m. 1. Annual General Meeting. 2. Dr. J Gladstone, "Recent Determinations of Molecular Refraction and Dispersion." 3. Mr. E. C. C Baly, "The Separation and Striation of Gases."

Saturday, Feb 11...Botanic, Inner-circle, Regent's-park N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. Hubert Parry, "Expressions and Design in Music."

The Telegraphic Address of the Society of Arts and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

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FRIDAY, FEBRUARY 10, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

INDIAN SECTION.

The meeting on Thursday, February 16th, when Sir William Hunter will read his paper on "The Progress of India under the Crown," will be held at 3 p.m. instead of at the usual hour, 4.30 p.m. The Marquis of Ripon, K.G., will preside.

CANTOR LECTURES.

On Monday evening, 6th February, Prof. J. A. Fleming, M.A., D.Sc., F.R.S., delivered the second lecture of his course on "The Practical Measurement of Alternating Electric Currents."

The lectures will be printed in the *Journal* during the summer recess.

HOWARD LECTURES.

Prof. W. Cawthorne Unwin, F.R.S., delivered the fourth lecture of his course on "The Development and Transmission of Power from Central Stations," on Friday evening, 3rd inst.

The lectures will be printed in the *Journal* during the summer recess.

STOCK PRIZE.

For the Decoration of Part of the Interior of a Building.

The Council of the Society of Arts are prepared to offer, under the terms of the Stock Trust, a Gold Medal, or a Prize of £20, for competition amongst the students of the Schools of Art of the United Kingdom, at the annual competition held in 1893.

The prize is offered for the best original designs for an Architectural Decoration, to be carried out in any or all of the following processes, *e.g.*, painting, stucco, carving, mosaic, or any other process.

This Architectural Decoration is to be either for the side of a room, or a hall, a ceiling, or the apse or side of the chancel of a church, or any suitable part of the interior of a building.

The designs must be on imperial sheets. Each set must consist at least of a coloured drawing to scale of the whole design of decoration, and two coloured drawings of details on separate imperial sheets. Mere patterns or sketches of details, without the mouldings or borders necessary to make up a complete decorative scheme, will not be taken into consideration. The designs must have been made during the previous school year.

The designs are to be submitted, with other school work, in the usual manner, to the Department of Science and Art, in April, 1893. Each of the imperial sheets, forming a set of competing designs, must be marked, "In competition for the Stock Prize," *in addition* to being labelled or staged according to the regulations of the Department of Science and Art.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Tuesday, 7th instant. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., M.D., Sir Edward Birkbeck, Bart., Sir Edward Braddon, K.C.M.G., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Michael Carteighe, R. Brudenell Carter, F.R.C.S., Lord Alfred S. Churchill, Francis Cobb, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., Prof. J. Dewar, M.A., F.R.S., Major-General Donnelly, C.B., Sir Henry Doulton, James Dredge, Prof. C. Le Neve Foster, D.Sc., F.R.S., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., C. M. Kennedy, C.B., J. Biddulph Martin, John O'Connor, B.L., W. H. Preece, F.R.S., Sir Robert Rawlinson, K.C.B., Prof. W. C. Roberts-Austen, C.B., F.R.S., Sir Owen Roberts, M.A., D.C.L., with Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, January 24, 1893; W. H. JAMES WEALE in the chair.

The paper read was —

THE THEORY OF STORIATION IN ART.

By HUGH STANNUS, F.R.I.B.A.

§ 1.—DEFINITIONS.

STORIATION is that section of the rules of Applied Art which governs (*a*) the Selection and (*b*) the Representation of Meaning in the decoration of objects.

The Selection will be treated of in §§ 4 to 8.

The Representation will be treated of in §§ 9 to 14.

The Meaning must be definite and intelligible. Much decoration consists of mere geometrical lines or brushwork without any direct meaning; and this is, of course, excluded.

The Objects may be anything, from a sculptured Building to a painted Chair-cloth, which can be made more beautiful by the aid of Art.

STORIATION, as being mainly Literary, lies outside the two great Artistic Virtues—Truth and Beauty.

Truth of imitation is first—the imitation of the forms around: the gathering of artistic detail.

Beauty is second—the selection and arrangement of the gathered detail of Line, Mass, and Texture, in pleasing combination, proportion, modulation, variety, &c.

Meaning is the third—the beautiful arrangement of truthful imitation having something added, beyond what they can give, which appeals to the Intellect, and tells a Story.

The WORD is a new one; and the writer, who is responsible for it, recognises the onus of shewing:—the necessity of an equivalent—the fitness—and the analogy with existing words.

This NECESSITY came when the early peoples began to record or tell stories on their Tent-cloths or Cave-faces, *i.e.* to shew to whom these belonged.

As developed, there are seven branches included in the word:—

Inscriptions, &c., the most simple,
Heraldry,
Symbolism,
Landscape-painting,
Iconography,
Portrait-painting, and
Historic-painting, the highest.

The same man or woman might do all these but we are justified, by the Division-of-labour in Art, in regarding them as separate.

The two often-used words:—"Iconography" and "Symbolism"—cover only half the ground: Historic-paintings, such as Sir Frederick Leighton's at South Kensington or those in the corridors of the Houses of Parliament, are neither Iconographic nor Symbolic (except in a very far-fetched sense) and neither are the Names of potters and potteries—which are yet part of the decoration in the Keramic Gallery at South Kensington. Heraldry, which is often the only clue to authorship and date in Architecture, is (by reason of giving information), a branch of Storiation; but it lies outside of the two often used words. Hence the necessity for one single, comprehensive, term for the whole.

The FITNESS will be perceived in the following:—

The ANALOGY will be seen on reading:—in Harrison's "Description of England", 1580:—

"* * * only the stories in the glass windows excepted";

in Milton's "Penseroso", 1637, line 159:—

> "And storied windows richly dight,
> Casting a dim religious light
> * * * * ";

and in Gray's "Elegy", 1749, line 41:—

> "Can storied urn or animated bust
> Back to its mansion call the fleeting breath"

§ 2.—DIVISIONS.

There are 3 mental Stages in the process of storiating an object:—

The PURPOSE, or function for which the object is intended, will be ascertained, § 3.

Those IDEAS, associated directly or collaterally with the Purpose, which are capable of artistic expression, will be considered, § 4.

Those METHODS, of representing the Ideas which are technically possible, will be selected § 9.

§ 3.—PURPOSE.

The PURPOSE of the Object is not at the Artist's choice. It is one of the data of his work; and it (generally) determines the treatment.

§ 4.—ASSOCIATED IDEAS.

In considering IDEAS: the storiationist may either dig deeply or dig widely. He may

search back, far into the Past, and shew the evolution of the particular subject, in its direct descent; or he may survey widely in contemporary manners and customs, and shew the cognate subjects, in collateral descent.

Thus, in a THEATRE, the storiation might trace the Evolution from the old Greek Tragedies, which were religious and patriotic functions, with Fate and controlling Power involved in their action—through the Comedies, no longer religious but for class amusement, in which the Gods were ridiculed and relegated to the background while human craft and passion constituted the weft of the fabric — through the Miracle - plays of the Middle Ages—the Moralities of the Renascence—the Plays of the Shaksperian cycle—down to the Comedy-of-Manners of the present day.

Or, on the other hand, the contemporary varieties of the art:—Symphony—Oratorio—Opera — Passion-play — History — Tragedy—Comedy—Pantomime—as they are modified and mingled in various countries, might be exhibited.

These two directions, in which the Ideas are sought, will perhaps impress upon people the fact that they are not isolated; but links in two Chains, one reaching back to the past beginnings of things, and the other by community of Art joining all present existences, and so forming that net of sympathy which encloses all.

§ 5.—GROUPS OF IDEAS.

The ideas connected, directly or collaterally, with the purpose of an object are innumerable; and it is impracticable to set them down in order; but they may be divided into groups as follows:—

(*a*) Those which are appropriate to the purpose (see § 6).

(*b*) Those which are incongruous (§ 7), and

(*c*) Those which are indifferent (§ 8).

An instance might be seen if, to choose a homely one, an embroidered Seat-cushion were to be decorated with the imitation of:—(*a*) Moss and Violets, (*b*) a Bird-nest with Eggs, and (*c*) Bows, and Quivers, and Garlands. And the same picture, *e.g.*, of Water with lilies, might be appropriate, incongruous, or indifferent, according as it was applied to:—(*a*) a Splash-cloth, (*b*) a Chair-cloth, or (*c*) a Table-cloth.

Some further illustrations of Ideas and of methods are given; but it should be observed that they are offered, not as Examples to be followed in all cases, but, as Instances which are near at hand to a dweller in London. There is much storiation in the Exhibition buildings at Chicago, judging from the interesting description by Sir Henry Wood in the *English Illustrated Magazine*, and there is some in the details of the "Griffin" monument; but the former is distant, and the latter is somewhat unworthy.

§ 6.—APPROPRIATE IDEAS.

CHURCHES have always been places for the decoration of which the people brought of their best; and the decoration always had meaning. In fact: the Stories were painted or carved, for the purpose of Teaching, long before it was realised that they contributed towards the Beauty of the whole. And each place in the Church had its special set of subjects which would affect the worshipper more appropriately or more strongly there than in any other.

The Portal, by the sculptures, reminded him of the Presence into which he was about to enter, and of the Heavenly Host which surrounded him.

The Baptistry, through the Twelve Apostles as witnesses to the Faith, reminded him of the necessity to keep it pure.

The Nave, with its Old Testament or Pre-Christian History, shewed the times of Preparation.

The Chancel, with the life of Christ, shewed the times of Revealing.

The Apsis, with the figure of the bidding Saviour, invited him to come.

The Cupola, with its display of the Resurrection and Triumph of the Saviour, assured him of Blessedness.

The Wall of Exit, with its Judgement-scenes, warned him of Responsibility.

These are some of the Ideas which were portrayed; but they were often varied; and a complete collection of the various Schemes of Storiation, properly indexed, would be of great use.

The Windows, or eyes of the Church, have always been a favoured place for Storiation. In these are opportunities for the Heavenly Hierarchy, the Angelic Chorus, the Bible Persons, the Teachings of the Lord, the Local Hagiology, &c.; and, as they are often given as Memorials, some personal allusions are admissible.

The Pulpit might be treated in consonance with Paul's advice:—"Preach the word * * *, reprove, rebuke, exhort * * *" (2 Tim. iv. 2); or, as in that at Pisa, erected at the time when the

Preacher had become important, with the so-called "Liberal Arts":—Rhetoric, Arithmetic, Geometry, Music, Astronomy, Philosophy, Grammar, and Dialectics—grouped round the central support, as handmaids to the chief sister Theology.

For the Choir, when separated from the Chancel, a fine idea may be taken from the successive invocations of the Canticle, "O all ye works of the Lord, bless ye the Lord: praise him and magnify him for ever", with its grand crescendo from the Natural-phenomena, through the Animals, and Man, up to the Spirits of Just men made perfect—"O *all* ye works of the Lord: praise him and magnify him for ever". The "Te Deum" has been used here; but it should be observed that—"laudamus Te" is only in the preamble. The hymn is really a prayer—"We therefore pray Thee help Thy servants"—and as such, it would be more appropriate in the Nave, where the people sit.

The LOCAL-CULT—of the Patron Deity, Patron Saint, or Collegiate Body—has always been a strong power in storiation. Two instances—from the Acropolis at Athens, and the Vatican Palace at Rome—may be given.

At ATHENS, to the old Greek, the great statue of Athene was of the guardian deity of his city and nation. She was the "Pro-machos"—the fighter-in-front—like the great Twin-brethren of the Romans, sung by Lord Macaulay. The mariner saw her helmet as he rounded the promontory; and felt she was also the guardian of himself as much as of his nation. The chruselephantine work of Pheidias, within the shrine, was dedicated to the same goddess—as "Victory-bringer"; and all around—on the Peplum, the Pediments, the Panathenaic frieze, or the Metopes—told the Stories of her or of those other deities about whom Miss Harrison has unravelled the myths in so delightful a manner.

At ROME were the headquarters of that vast ecclesiastical organisation which sought to formulate and spread the faith of the Galilean Fishermen until it should be universally accepted. The head of this—the Father of the faithful—was wont to receive the Ambassadors from other States in the *Sala Regia;* and this was appropriately decorated to show the victories or triumphs of this Church over those who had differed-from or opposed it. Thus—the humiliation of the Emperor Henry IV. by the Pope Gregory VII., in 1077—the humiliation of the Emperor Frederick Barbarossa by the Pope Alexander III., in 1177—the return of the Pope Gregory XI. from a semi-subjection at Avignon to independence at Rome, 1377—the defeat of the Moors at Tunis in 1553—the defeat of the Turks at Lepanto, in 1571—the overthrow of the Huguenots at the massacre of St. Bartholomew's, in 1572—each represented in a large picture, had a lesson to convey to those Envoys from the foreigners the moral of which was not far to seek. Two of the *Stanze,* which are approached from the Loggia of Rafaelle, on the same floor, have similar significant storiation: the *Sala di Costantino* shows the Victory, and the Baptism of the first Christian Emperor, and his Address to his army, and also his Donation (of the city of Rome) to one of the Popes; the *Sala d'Eliodoro* shows the Expulsion of Heliodorus from the Temple, the Repulse of Attila from Rome by the Pope Leo I., the Liberation of St Peter, and the Conversion of the skeptical German Priest; all of which would be food for thought on the part of opponents, in demonstrating the venerability, the far-reaching power, and the benevolent intentions of the Keepers of the Faith.

HISTORIC MONUMENTS must, of necessity be storiated. The Trajan Column, at Rome records the campaign in Dacia. The Vendôme Column, at Paris, records the campaigns in 1805 The Arch at the top of the Champs Elysées at Paris, records other Napoleonic campaigns up to and including the battle of Ligny in 1815. The Ideas in these appear to have been generally: a glorification of the destructive arts, with representations of Incidents in the campaigns, and of the Spoils taken from their enemies.

PERSONAL MONUMENTS are also often storiated. The Ideas, associated with Monuments, have been well classified by Mr. C Daly under the three heads of:—

> DEATH—or those connected with the sense of the Loss of a friend, of the Silence of the tomb, and of the Decay of the body—
>
> GLORIFICATION—or those connected with the personal Appearance, with the Virtues, the abilities or tastes—and
>
> FAITH—or those connected with the teachings of Religion, and the belief in Immortality.

The first of these deals with the old Pagan "Properties"—of the inverted Torch, the Winding-sheet, and Skull and Crossed-bones

The second informs us what particular Virtues the deceased favoured, or wished to be thought to practise, as in the monument

erected by Can Signorio della Scala, for himself, at Verona, after he had murdered his brother, which bristles with twelve statues of selected Saints and Virtues. A more worthy instance is the monument to the late Prince Consort in Hyde Park, which shows a Portrait-statue, and alludes to his generous and discriminating encouragement of the Arts and Sciences, and the international character of his sympathies. Personal tastes are shewn in the fine Frieze round University Hall, Gordon Square, to the memory of Henry Crabb Robinson, which collects, as in a conversazione, some of the men and women he knew. Another instance is seen in the memorial to Professor Fawcett, intended by Sir Henry Doulton for Vauxhall Park. There is a Portrait-statue, with a figure of Victory behind; and in the panels of the pedestals are subjects appropriate to his character—Courage, Sympathy, Justice, and Truth; and to his work—Good News, Bad News, a Woman postal-clerk, and India.

The third group of Ideas is more consonant with our feelings in England; and instances will occur to every one who gives attention to the subject. We English are reticent in feeling, and object to spend on sentiment that which may be better used for benevolence; and our climate is not favourable to hypæthral sculpture; but a walk through a Cemetery is instructive.

Social Life and Civilisation often give Ideas, Some of these are effectively worked-in at some of the Mairies or official centres of the districts of Paris. It is there that Marriages are solemnised, that Births are registered, and that the Conscription-lists are prepared of those on whom their country has claims for duty.

The decoration in that of the 13th district by M. Boulanger is in a classic style; and shows, on the four walls, the four Ideas of: — Marriage — Manhood — Family-life — Patriotism.

The Hotel de Ville, which was destroyed during the second siege of Paris, contained, in the twenty-eight cove-panels of the great Hall, a History of civilization. As these were so complete in arrangement, a list of the subjects is here given, with translations of the Latin mottoes :—

1. Mother Nature—"The race of men arises."
2. Contest with Animals.—"He fights against the wild beasts."
3. Shepherd-life—"He holds the flocks in his hand."
4. Early metal-working—"He is pressed by various labours."
5. Spinning and Building—"And they prepare clothes and houses."
6. Slaying a Ram—"The gods are appeased with a sacrifice."
7. Cornfield—"The harvest enriching the husbandman."
8. Use of the Vine—"He dissipates his troubles."
9. Music—"Songs harmonise with the lyre."
10. Astronomy—"He marks-out the months and the stars."
11. Navigation—"He sends-out ships on the sea."
12. Steam—"Force more intense from confinement."
13. Drama—"The two-faced mask weeps and laughs."
14. Metaphysics—"Man in intellect approaches deity."
15. Theology—"Instruction confirms faith."
16. Physics—"He seeks the causes of things."
17. Justice—"The goddess avenger of crimes."
18. Government—"Authority administering affairs well."
19. Geometry—"He measures everything in the world."
20. War—"Thus cruel wars assail."
21. History—"Clio singing of heroic deeds."
22. Medicine—"Diseases are cured by the physician's art."
23. Benevolence—"Charity is the nearest to God."
24. Oratory—"He rouses, he delights, he teaches"
25. Fine Arts—"The three arts flourish as one."
26. Choral-dance—"A dance to the sounds of a flute."
27. Agriculture—"Abundance scatters her fruit."
28. Fame—"She shews the way to the stars."

TEXTILE OBJECTS, *e.g.* Curtains &c., seem to invite allusions to:—Arachne, the ambitious embroiderer — Penelope, the faithful wife — Dorcas the benevolent widow—or that unfortunate Lady of Shalot—among others.

FIRE-PLACES invite:—the Ploutonic cycle —Hephaistos and the Kuklopoi—King Alfred and the Cakes—the "Golden Milestone" of Longfellow—and many other pleasant ideas to the home-loving Englishman.

DRINKING-FOUNTAINS need not always shew us heathen Nymphs, aquatic Plants, and Dolphins; but may represent:—Abraham's messengers—David with the dearly procured water—the Samaritan well—Sir Philip Sidney —or the big Sister of to-day lifting her little sister to have a drink—&c.

In thus interweaving the Ideas with the Decoration—there will be a leading-out of the mind by the associations—an interweaving of the interesting with the commonplace—a connecting of the lesser with the greater—a looking from the lower to the higher—which it is the privilege of Poetry to add to Life; and which Storiation adds to life's Surroundings.

§ 7.—INCONGRUOUS IDEAS.

The writer leaves this invidious portion of his subject—unwritten.

§ 8.—INDIFFERENT IDEAS.

Some PURPOSES of objects are so indefinite or uninteresting, and their associated Ideas are so commonplace, that these are passed-over; and the storiationist arranges some scheme which, though not suggesting the Purpose, is yet *not incongruous.* An instance exists in the Refreshment-room at the South Kensington Museum, where the beautiful panels by Mr. E. J. Poynter, R.A., shew the 12 Months and the 4 Seasons instead of such subjects as would, though appropriate to a Grill-room, be commonplace and unelevating. On buildings and other objects, which are indefinite, the following may be used:—Bible History, always—Local History and Tradition, often —and Seasons and Times, generally.

BIBLE HISTORY is universal in every time and country, from those grand Byzantine Gates and Frontals, onwards.

LOCAL HISTORY instances are so plentiful, that:—the history of Manchester by Mr. Madox Brown, in the Town-hall of that City —the "Chevy Chase" by Mr. W. B. Scott, at Wallington in Northumberland—and the "Dragon of Wantley" by Mr. E. J. Poynter at Wortley need only be referred-to.

SEASONS and TIMES are shown at South Kensington (as before mentioned).

THE LIFE OF MAN is pathetically shewn round the drums of the terra-cotta Columns by Godfrey Sykes, in front of the Lecture Theatre at South Kensington. These have been so fully described by Mr. Pollen that no more need be said than to refer to his pamphlet on the subject.

BESTIARIES are found in many places:— Westminster Chapter-house, and the great Hall at Padova, being instances.

The LITERATURE of a country will furnish a perennial supply for this group; and all workers in Decorative Art feel a debt of gratitude to their brother Artists in this, for their inspiration.

§ 9.—METHODS OF REPRESENTATION.

The METHODS, by means of which the associated Ideas are represented, may be divided into Groups as follows:—

I. Imagination (including in that division all Poetic and Abstract renderings).

II. Reality (the representation of Facts that have been or are).

III. Epigraphy (not representation by Picture but by Word).

These GROUPS are further sub-divided according as the Methods are treated, as follows:—

A. Mythically, including under this subgroup such as are:—(1) supernatural, (2) not in ordinary experience, (3) not situated on our own globe, (4) involved in pre-historic obscurity, (5) the creation of Poets and other "makers" of literature, and (6) the personifications of abstract Ideas.

B. Historically, *i.e.*, in a "matter-of-fact" manner, with no meaning beyond that which is shewn on the surface.

C. Typically, *i.e.*, such as are selected because they shew the desired characteristic in a greater degree than others.

D. Symbolically, *i.e.*, such as have another or inner Meaning, beside or beyond that which is apparent at first sight.

The complete List of Methods is shewn in the Table, § 10, on page 267. It should be here observed that it has not been always possible to classify logically; and some methods are grouped by affinity rather than by evolution.

§ 10.—Table

of the 22 Methods of Storiation, by means of which Ideas are Represented in the Decoration of Objects.

I. Imagination	A. Mythic ...	*a.* Episode.
		b. Personage.
		c. Locality.
	D. Symbolic	*d.* Attribnte
		e. Device, &c.
		f. Heraldry.
		g. Colour.
II. Reality......	B. Historic..	*h.* Event.
		i. Person.
		j. Place.
	C. Typic......	*k.* Occupation.
		l. Worker.
		m. Scene.
	D. Symbolic	*n.* Action, &c.
		o. Instrument.
		p. Result.
III. Epigraphy	B. Historic	*q.* Name (only) of Event, Person, or Place.
		r. Word (only) for Idea.
		s. Date (only) of Event.
	D. Symbolic	*t.* Allegory, &c.
		u. Motto, &c.
		v. Letter, &c.

§ 11.—Details of Methods.

(*a*) The Episode, from Myth or Poetry, is sed when no suitable Historic Events can be ound which will represent the desired Idea.

Instances of the Mythic Episode are seen n :—the "Orpheus singing" of the Meeting-oom frieze at our Society's House—&c.

(*b*) The Personage, *i.e.* Ideal Portrait, ncludes such as are classified in the 6 ivisions of group A in § 9., *e.g.* Gods and oddesses, and the personification of the irtues, Elements, Planets, Arts, Sciences, c.

Instances are seen in :—the "Thames" of e Meeting-room frieze—the "Fortitude", Faith", "Charity", and "Justice", of the ordon Monument—the "Britannia" of the ronze Coinage—the Figures on Sir F. eighton's Jubilee Medal—&c.

(*c.*) The Locality, *i.e.* Ideal View, includes ch as are mentioned in § 9.

Instances are seen in :—the "Elysium" nd "Hades"] of the Meeting-room frieze—c.

(*d.*) The Attribute is the representation of n object which has been *given-up* to a certain e, so that, on seeing it, the association of user or usage arises in the memory. The arland of Fruit, which was hung about the ltar and the Victim, as also the Patera, ase, and other sacerdotal appliances, when presented on the Roman Temples, thus suggested their religious Ritual. So also other objects in consequence of their association with their particular Gods and Goddesses came, in time, to suggest them; thus the Eagle and Thunderbolt of Jupiter, the Lyre and Laurel of Apollo, the Aigis and Owl of Minerva, &c. Afterwards to suggest the Character or Quality; thus the Eagle for Majesty, the Laurel for Peace, the Owl for Wisdom. When iconographic Hagiology was crystallised, in the middle-ages, the representations of Martyrs included the Instruments which were associated with their martyrdom, *e.g.*, the Flaying-knife of Bartholomew, the Wheel of Catherine, &c.; or with some other Event, *e.g.* the Keys of Peter, the Serpent-chalice of John, the Giant-form of Christopher, &c.; or some Companion, *e.g.* the Stag of Hubert, the Assyrian monsters afterwards adapted from Ezekiel for the Evangelists, the Pig of the Paduan saint, &c.

The Authorities on this subject are :—Durandus, Ripa, Didron, Mrs. Jameson, &c.

Instances are seen in :—the Scales and Sword of Justice—the Anchor of Hope—in many churches—&c.

(*e.*) The Device is the representation of a scene or object. Those on the shields of the "Seven Chiefs against Thebes" are minutely described by Aischulos (d. 456 B.C.): three of them were accompanied by Mottoes; but these latter were not an integral part of the Device.

The Emblem was a short Verse or motto, with an explanatory Picture.

The Impresa, as adopted by the renascence Italians, on *undertaking* any adventure, was a small Picture, with an explanatory motto.

These two latter were so similar in their result—the picture and the motto—that the words came to be used synonymously.

The Authorities on this subject are :—Alciati, Giovio, Ruscelli, and Bargagli; followed by Cats, Quarles, Whitney, &c., down to our own venerable member, Mr. John Leighton.

Instances are seen in :—The "Cave Canem" picture from Pompeii—many Printers'-marks—many examples of the recently revived "Ex Libris" taste—&c.

(*f.*) The Heraldic Shield is well-known; and need not be particularised.

Instances are seen in :—The Royal shields on Westminster Bridge—those of the four kingdoms, together in quarterings or separate, on the Houses of Parliament—&c.

The Heraldic Badge is (1) a charge taken

from the Shield, (2) the Crest taken from the Wreath, and used independently, *e.g.*, the Portcullis, Feathers, &c. ; or (3) Objects taken not from Bearings but from any other convenient source, *e.g.*, the sprigs of Broom, Rose, Shamrock, &c., in the caps, or the Knotted-cord on the coats of retainers.

Instances are seen in :—much of the carved enrichments of the Houses of Parliament.

(*g.*) The SYMBOLIC COLOUR was more used in the middle-ages, though the revival of stained-glass, during the last twenty-five years, has drawn attention to it.

Instances are given in Chap. III. of Prof. F. Edward Hulme's interesting work on the Principles of Ornament.

(*h.*) The EVENT is the representation of an actual occurrence in Local or National History.

Instances are seen in :—The "Victors at Olympia" of the Meeting-room frieze—the Capture of Acre, and the Forgiveness of the Chaluz archer, in the Richard I. pedestal-panels in Palace-yard—the Pictures from the Civil War, in the Houses of Parliament—&c.

(*i.*) The PERSON, *i.e.*, a known Individual, shewn by a Portrait, is used singly or collectively.

Instances are seen in :—The statues of Artists in front of the Royal Academy—the mosaics round the Loan-court at South Kensington—&c., for the former treatment ; and in :—the Crabb Robinson frieze at the University Hall—the Podium of the Albert Monument —&c., for the latter.

(*j.*) The PLACE, *i.e.*, the View of a particular Town or Country, is represented by :—Inhabitants, as in the "Harmony welcoming the Nations" by Lameire—Views, identifying it by well-marked natural surroundings, *e.g.*, Naples by Vesuvius ; or by well-known buildings, *e.g.*, ancient Rome by the Coliseum, or modern Rome by St. Peter's—or by Maps, *e.g.*, in the Vatican gallery.

Instances of this, in London, are not known to the writer.

(*k.*) The OCCUPATION is represented by figures engaged in such as suggest the required Idea.

Instances are seen in :—the Industrial Arts of Peace, and of War, at South Kensington—the Arts and Sciences in the Albert Hall frieze—&c.

(*l.*) The WORKER is not individualised as a Portrait, but represented by the typical Craftsman, clad in his Working-clothes, with his characteristic Tools and Specimens of his Craft.

Instances are seen in :—the Figures, typifying the chief Livery Companies of the City of London, in the Guildhall Council-chamber—&c.

(*m.*) The SCENE, *i.e.*, not any particular Place, but a generalization of Climatic-character, is represented by :—Inhabitants, as in the actual Place—the Flora, *e.g.*, the Torrid, Temperate, and Arctic Zones, by the Palm and Cactus, the Oak and Grass, the Fir and Moss—the Fauna, *e.g.*, the above by the Lion and Crocodile, the Horse and Otter, the White Bear and Seal.

Instances of this, in London, are not known to the writer.

(*n.*) The SYMBOLIC ACTION is a Dramatic rather than a Graphic Method of Expression and it is included here only to complete the classification. It is more used in the early stages of language than when they have become perfect and flexible means of communication.

Instances are given in Chapter II. of Prof. Hulme's book before-mentioned.

(*o.*) The INSTRUMENT is such as is commonly used in any Occupation, represented singly, or in groups or trophies, *e.g.*, the Palette and Brushes of Painting, the Telescope, Retort, Pulleys, &c., of other Occupations, &c.

Instances are seen in :—the Trophies of Tools hung on each side of the Exhibition certificate, which is used as a frontispiece to the book—"Alfred Stevens and his Work," lately published.

(*p.*) The RESULT is the effect of the Worker using his Instruments to produce objects of Art, &c., gather Food, prepare Shelter, capture Arms, &c.

Instances are seen in :—the paintings of Silversmithery in the Loan-court at South Kensington—the reliefs of Indian and French Arms on the Wellington Monuments—&c.

(*q.*) The NAME is used singly or in series to represent Event, Person, or Place, when the position or means require such extreme simplicity.

Instances are seen in :—the Victory-tablets round the Wellington Monument—the Potters round the columns in the Keramic Gallery at South Kensington—the Potteries in frieze of same Gallery—&c.

(*r.*) The WORD for an Idea, singly or in series, is used under similar circumstances.

Instances are seen in :—the words "Agriculture", "Commerce", &c., recording the branches of our Society's Work, in the Meeting-room cove—&c.

(*s.*) The DATE is useful, among other pur-

poses, in recording the erection or completion of Buildings, &c.

Instances are seen in:—many Public Buildings in London, though not so universal as they should be.

(*t.*) The ALLEGORY (including in this the Parable and Fable) is a Literary rather than a Graphic Method of Expression; and is included here only to complete the classification. Its Function in literature is analogous to that of the Symbol in art, *i.e.*, to *speak otherwise* than by the mere primary meaning of the word or objects. Thus the "Pilgrim's Progress" is an Allegory; and the "Catherine Wheel" is a Symbol.

(*u.*) The MOTTO (including in this the Proverb, &c.) is used under similar circumstances as the other methods in this Group III. It is the most direct method of telling a Story; but its interest is mainly literary: the Artistic value depending on the decorative appearance (or otherwise) of the Alphabetic-characters, *e.g.*, the Cufic letters in the Alhambra inscriptions.

Instances are seen in:—the Quotation from from Spenser in the Octagon-room of the R.A.—many Sword-blades—the "Waste not; want not" of the Bread-platter—&c.

(*v.*) The LETTER is the most simple; but it is not without its symbolic value.

The MONOGRAM, in its earlier style of conjoined letters and its later style of interlaced ones (ciphers), has been very useful to the Antiquary.

The SIGN, conventionally degraded from picture-writing, used for the Planets, Zodiacal Constellations, Metals, Alchemic Decoctions, &c., has interest and value.

The REBUS, or substitution of representations of *things* for the proper name, is of great help to the Antiquary; and may be classified in this group.

Instances are seen in:—the Alpha and Omega—the Chi-Rho—the Ciphers on Railway carriages—the chemist's Show-bottles—many old Monasteries—&c.

§ 12.—COMBINATION OF METHODS.

These METHODS have been sometimes combined:—the attribute included in the representation of the Personage—the Person in the Event—or the Result (*e.g.* the trophy of game) with the Instrument (the fowling-piece).

The MYTHIC has been combined with the Historic in some of our Monuments, where the Neptunes and Sea-divinities support the English Captains, the figures of Fame crown the dying Generals, or the Skeletons are throwing darts or grasping at the fainting Ladies.

MYTHIC PERSONAGES have been also substituted in representing historic events. The crossing of the river Rhine near Nimeguen, by the French King, Louis XIV., in his attempt to conquer a portion of Holland, took place in 1672. At the palace of Versailles, near Paris, this event is represented as follows:—a man, presumably a portrait of the King, drives a chariot towards the L.H. side of the picture, and threatens some figures there with a "thunderbolt"; the chariot is pushed from behind by Hercules, who is also striking with his club at an old man who sits on the ground with an overflowing urn, representing the river; Phœbus lights the chariot, and Minerva guides the driver; while several winged females (in the air) are carrying chaplets and palm-leaves, and blowing trumpets. The whole is an instance of the treatment of Reality as if it were Imagination.

The series of the History of Maria de' Medici, in the Louvre, also shows the mixture of Mythic-personages with Historic-persons.

§ 13.—OVERLAPPING IN REPRESENTATION.

Sometimes in an Object the same person may occur twice.

Thus, in the Albert Monument, Michelagnolo is represented on the West side among the Sculptors, and on the East side among the Painters.

Similarly, in the storiation of a church, if the Evangelists are separated from the Apostles, as is generally done, John and Matthew will be represented twice. So also with any Person who is known in two characters.

§ 14.—DUPLEX STORIATION.

DOUBLE REPRESENTATION of the same Idea is often found in Mediæval Storiation.

TWO BOOKS, published very early in the middle ages—the "Speculum Humanæ Salvationis" and the "Biblia Pauperum"—both give events from the New Testament history, each accompanied by other events in earlier history, with inscriptions, in what is known as the Type and Antitype manner. They are very systematically worked-out, shewing the evidence of much time having been spent upon them; and these, which were doubtless Handbooks to the artists of the time, accustomed people to pictures of the N.T. history with the earlier events represented in the backgrounds; and thereby made the storiation more interesting.

An ANALOGOUS TREATMENT was followed in the Passion-play at Ober Ammergau, during the Last Supper, when parallel scenes—of the Israelites gathering manna, and of Melchizedek offering bread and wine—were shown as *tableaux vivants* in the background, while explanatory words were chanted by the chorus.

Mr. WALTER CRANE, who has done so much for decoration and for artistic books in England, has adopted the above expedient very charmingly in his books :—" Bluebeard ", where behind the tempted Wife with the Key is shewn, on a curtain, Eve with the Apple—" Puss-in-Boots ", where at the marriage-feast is shewn, on the tapestry, the other Cat that killed the Rat—" Frog Prince ", where is shewn, on the table-cloth, that other Frog who would a wooing go—and in " Beauty and the Beast ", where is shewn, on the harpsichord, the Beasts charmed by Orpheus.

§ 15.—AVAILABLE SPACES.

The number, size, and proportion of the available Spaces will always govern Storiation; and of this, the Artist will be the best judge.

In connection with this: an amusing instance of a space being too large, is on record. It was stated that at Washington the painting of the grand historic Frieze was brought to a standstill, as there was " not enough history to go round " ; so, it was said at the time, they would have to wait until they had made some more history.

§ 16.—INTERNATIONAL SELECTION.

In the choice of Persons or circumstances to illustrate any idea it is well to remember: that human achievement belongs to no one country; and to select the most representative men and women regardless of nationality; thus making the idea truly international. The storiation that, while including some very second-rate French authors, could ignore Shakspere and Milton, may be prompted by patriotic motives ; but can only have a cramping effect on the intelligence of the inhabitants. It is pleasing to observe, in the statues on Pennethorne's University building, that, of twenty-two great men, twelve are of other nations, from Plato and Galen to Cuvier and Linnæus ; and so, also, in the great Artists in the podium of the Albert Monument.

§ 17.—DIDACTIC USE.

It is further useful in teaching. Paulinus, a bishop of Nola in the V. century, as quoted in Didron (Bohn's edition) I. 4, and Geoffrey, a bishop of Auxerre in the XI. century, as quoted *ibid.* I. 5, both give reasons which are interesting. Dante in the Purgatorio gives two instances of this Didactic value :—

In Canto X. 28 to 51, a marble relief, shewing humilty towards superiors, by Mary; in line 52 we read further—" *Un' altra storia nella roccia imposta* " which shews humility towards equals, by David; and in line 70 we read he moves his feet to examine another " story " which shews humility towards inferiors, by Trajan. When we know that these Sculptures are in that circle of the Purgatorio in which the sin of Pride is punished—their appropriateness is apparent.

In Canto XII. 25 to 72 we read of another Marble shewing instances of humbled Pride, from Satan to the destruction of Troy; and he gives as the purpose of these stories—" *Si che veggiate 'l vostro mal sentiero* ".

In the Palazzo Pubblico at Siena is a very interesting Fresco shewing the results of Good and Bad Government, as in an antithetic parable.

And as a last instance: that which is the most beautiful of all, may be seen the noble ruin of Lionardo's in that Refectory where as often as the Brothers met together they were reminded to—" do this in remembrance of Me ".

§ 18.—EMOTIONAL VALUE.

It is found that Pictures excite the multitude more than Writings, partly by association and partly by being more quickly intelligible.

The celebrated Italian, NAPOLEONE BUONAPARTE, who was for some time Emperor of the French, gave an interesting instance of this when he was contemplating the invasion and Conquest of England in 1805. He caused the Bayeux Tapestry to be removed and exhibited at Paris, with a view to stimulate the passions of his subjects to attempt once more that conquest which the Tapestry shewed had been so easily accomplished before by William of Normandy.

It is also related that RIENZI, the unfortunate political Reformer of the XIV. century, commenced his appeal to the people of Rome by exhibiting, in various public places, Pictures, of the degradation of the city, on which he made speeches.

§ 19.—HISTORICAL VALUE.

This is one of the most important branches of the subject, requiring much space to

shew even the mere outlines of the ground to be covered. The Ideas which were chosen at various periods would form an interesting chapter of Storiation; but it can be only mentioned in this paper. And now that Archaiology is becoming, as an exact science, a worthy and necessary sister to History—this chapter is being written; and is yielding the most interesting and valuable results.

§ 20.—NECESSARY KNOWLEDGE.

In the PREPARATION of a complete scheme: the necessary knowledge will be seen to be great and wide. The Storiationist must know somewhat of many things; and also of the places where further knowledge is to be obtained.

Hence: the scheme has often been prepared, not by the Artist, who executed the work, but by the Learned-man (Priest, or Scholar) who alone had the grasp of the threads constituting the warp of their knowledge.

But the technical processes of artistic expression must always be considered; and some subjects, *e.g.*:—the Isolation of Oxygen, by Priestley—the Observation of the Transit of Venus, by Horrocks—the Identification of Lightning, by Franklin—which are easy in Painting or Relief, present great difficulty in Statuary; so also other subjects, *e.g.*:—a Fight for a Standard—or a Football scrimmage—are more clearly understood in isolated Statuary-groups than in flat presentment. Therefore the Artist who is to execute the work must be allowed (in consultation) to choose the exact treatment which inspires his mind. The choice of Ideas is mainly Literary; and that of Methods mainly Artistic. The Storiationist may select the Ideas in consultation with the Artist; and the Artist should determine the Method of representation in conjunction with the Storiationist.

In DECIPHERING storiation: much knowledge of the Mythologies and Histories of all Peoples is also required.

That of the Greeks and Romans has long been a part of School-curriculum: that of the Egyptians and Assyrians is a part of the equipment of Archaiologists.

That of the Hindu nations has been condensed into an admirable Handbook, by Sir George Birdwood, which explains much of the Hindu art that before was involved.

Mr. James L. Bowes, in the Notes at the end of his beautiful book—"Japanese Pottery" (Liverpool, 1890)—has done the same good service to the student of Japanese Decoration. When the beginner learns how every Plant and every Attitude of the plant, as also every Animal has a symbolic meaning—that, when one gentleman presents a picture of the Pine-tree, Bamboo, and Plum-tree to another, he is wishing him good fortune and promising eternal friendship—he will judge the work for its value *symbolically* as well as æsthetically; and much that is puzzling in their distribution or arrangement, now, will be then made clear.

§ 21.—READING THE STORIATION.

The Purpose of a building may often be shewn by its exterior decorative sculpture or mosaic.

The Classes of buildings may be determined, generally, by the architectural treatment of the Roof and of the Doors and Windows. Thus—Museums, Hospitals, and Factories—all shew their class; but the particular kind of —Object, Disease, and Manufacture—is not shewn by the exterior Architecture; and can only be ascertained when Sculpture assists by Storiation.

It does for Architecture that which Words do for Music. Music and Architecture suggest; but Words and Storiation can also describe, and inform. Hence the value of Storiation when appropriate Ideas are shewn. An example is seen in the large building, on the west side of Whitehall, which contains the Home and Foreign Offices. Each division of the building has seven spanrail-panels with low-reliefs of mythic personages, below; and six circular niches with busts of historic persons, above.

In the Home-office the order is:—

(Spanrails.)	(Niches.)
Law	Gascoigne.
Agriculture	Sinclair
Art	Reynolds
Science	Bacon
Manufacture	Watt
Commerce	Smith
Literature	

In the Foreign-office the order is:—

Government	Elizabeth.
Europe	Drake
Asia	Livingstone
Africa	Wilberforce
America	Franklin
Australasia	Cook
Education	

This is not the occasion to speak of the splendid sculptural qualities of the sitting figures in the spanrail-panels; but the

thoughtful manner, in which the details are worked-out, is well worthy the attention of the passer-by; and the introduction of the Ideas of Government and education seems to suggest that Great Britain realises its duties towards the foreign possessions. But the chief point is—that the thoughtful spectator recognises the Purpose of each division of the building.

It is pleasing, in this connection, to see the spectators round the Albert Monument purchasing the penny Book which gives details of the persons represented; thus Storiation is incentive to Study; and gives interest in proportion to the Knowledge of the beholder.

§ 22.—The Central Idea.

All Pictures in Monumental Decoration should be arranged in connected Series, or sets. The impressiveness of a number increases—like the examples in Natural Philosophy—in square ratio.

If we view *one* picture—say of John Howard visiting a Lazar-house—we may observe a man accompanied by a number of officials in a horrible place with a great quantity of human suffering. But if we contemplate a Series of pictures—another of Elizabeth Fry seeking to reclaim the poor women in Newgate; and another of Florence Nightingale nursing the sick and wounded at Scutari—then we observe amid the varying circumstances of the Russian lazaretto of 1789, the English gaol of 1820, or the Turkish hospital of 1855, that there is one circumstance in which they all coincide—the benevolent and beneficent care of those who cannot care for themselves—and this central idea, which we trace in all, is the Idea of the Storiation.

So also, if observing representations or names of:—Moses, Joshua, David: then we would guess Hebrew worthies, for a School. If of:—David, Charles Martel, Alfred: then Patriot Kings, for a Palace. If of:—Moses, Lykurgos, Justinian, Napoleone: then Legislators, for a Senate-house. If of:—Napoleone, Hannibal, Charlemagne: then Generals who have crossed the Alps, for a Military School. If of:—Pliny, Cuvier, Linnæus, Owen: then Naturalists, for a Natural-history Museum.

This connecting of different Events or Persons by the central Idea, as if separate Pearls on the same silk, or separate Stones in the same setting, is an expedient which has often been used in our sister Art of Literature; and it is one of the great charms of Storiation.

§ 23.—Some Sources.

In Literature the Sources for Ideas ar many and copious.

The Bible is full of such, which are familia and dear to all; and from its riches may b picked-out such as are appropriate to all sort and conditions of men. For the Palace- David and Hezekiah: for the Judgment-ha —Samuel and Gideon: for Civic-life—ther are no events or persons, but the Proverb have been a rich store for Epigraphy: and fo the Peasant—Jacob and Ruth—among other

Other Collections which appear, almost, t belong to Humanity are Homer, Dante, an the beautiful Sanscrit legends which hav been presented to Western ears by Sir Edw Arnold.

Our own literature lies still nearer; an Chaucer, Spenser, Shakspere, Swift, an Burns, are ever fresh.

In our own time the Poets have shewn syn pathy with our Arts; and hence the works such men as Browning, Rossetti, Tennyso Longfellow, and Morris, are full of suggestio which have been used with avidity.

Contemporaneous events will also furni circumstances and incidents which might l utilised to give a point of interest to our wor

Work which sets down Facts, will increa in interest as time goes on, while that whic merely gives us the old Imaginations of Fame Victories, and Cupids, will soon cease have any.

And: further it may be averred that the are Saints and Heroes around, probab as worthy as some that have been official stamped, who (typically represented) wou make our work more worthy of our age.

§ 24.—Cautions.

Errors may arise in Place, Kind, a Quantity.

The Place, when Storiation is applied e ternally, may be on all buildings and on mo other objects; but, when applied internally, is more appreciated in public than in hor life.

On Functional features it should be avoide Thus the Niches of a building (which a decorative) might contain statues of State men, &c., but for the Telamones or supporti figures of a portico (which are functional) the should be no portraiture. A portico support by two William Pitts, or by Pitt at one si and Fox at the other, would be absurd.

On Borders, as a general rule, it should

voided; and should be reserved for Panels nd Friezes.

The KIND should not be too grave for its ace. People do not like high tension in their omes; and, when any storiation is introuced, it should be of a pleasing rather than arrowing character.

The QUANTITY should not overpower the sthetic nature of the decoration. It should e used rather as a "flavouring" than as the aple portion of the work, unless absolutely ecessary by the function of the object.

§ 25.—OPPORTUNITIES.

Storiation might be used, much more than at esent, in England. It is not the whole nor e chief gospel of Decorative Art. It will ot bring the Millenium; but it will add Meang to Beauty, as Beauty was added to Truth; nd, there are Mosaic-workers and Reliefculptors, in numbers, who could execute all at is required to make our Streets beautiful ith colour and delightful with Stories that ould again be as books to poor men.

And Indoors, in the house and the school, ere are spaces which it is the aim of some ell-known Societies to fill; and among the test of these are the efforts by Messrs. elwyn Image, Heywood Sumner, and others.

The writer, thus, pleads for more Storiation, r more of these "Histories and Sermons hich we can read without the trouble of rning-over the leaves" so that the surroundgs, and with them the lives, of our land may e made more beautiful.

DISCUSSION.

Sir GEORGE BIRDWOOD desired to thank Mr. annus for the very admirable exposition he had ven of the subject of his paper, of which, however, had no special knowledge himself, and the only rious remark he would make on it was one that ould occur to every one of artistic sympathies. e idea of storiation in the decoration of buildings s very delightful in itself, but, like symbolism nerally, it must be absolutely subordinated to art, at is, in the present connection, to the architecture the building so decorated. Of course art has a rpose, and this was to refine and elevate, but without servation. In domestic architecture, and particuly in the interior decoration of houses, the great d to secure was the impression of repose; and n certainly ought not to be irritated at every n you took, whether in your own rooms, or the public streets, by object-lessons in copyok morality, or the world's history. It was very minor point, but he took exception to some of the illustrations given by Mr. Stannus of the principles of decoration advocated by him. For instance, he gave as an illustration of the appropriate decoration of a cushion seat, its being embroidered with violets and moss, while he said it would be inappropriate to decorate it with a bird's nest with eggs in it. But, as between violets and moss, and a bird's nest with eggs in it, taken of themselves, surely the latter would be the more appropriate decoration for a cushion seat, for you might help to hatch the eggs! Of course the appropriateness of the decoration all depended on its treatment; and, provided the treatment was conventional, and it was clearly seen that the forms used in the decoration were nothing more than flat ornaments, it was of very little consequence what forms you used. This was, however, a very small criticism; and he had risen in response to the Chairman's invitation, chiefly to thank Mr. Stannus most cordially, in the name of the Applied Art Section, and of all present, for his most excellent paper. He was always philosophical, and learned, and earnest, and the present session of the Section could not have been opened with a more appropriate paper.

Mr. LEWIS DAY also thanked Mr. Stannus for his paper. No one, he said, could have listened to it without learning a great deal, but he felt inclined also to sympathise with Sir George Birdwood in his remark as to the necessary subordination of storiation (if we were to call it by that name) to decorative effect. He thought Mr. Stannus seemed either to ignore or to underrate the importance of this. That was the one point on which he should feel inclined to quarrel with him. The first business of decoration was to ornament. It was rather overweighted by any very serious meaning in it. He did not mean what he said to apply to decorative pictures; and if it was simply meant that pictures in decoration should be arranged in series, he entirely agreed with that; but with regard to the lesser art of ornament, with which he was more directly concerned—and Mr. Stannus evidently referred to that, because he alluded to textiles, fountains, and so on—he thought storiation was dangerously likely to hamper the free play of the artist's fancy. When people were in deadly earnest, they did not want ornament at all. Decoration and ornamentation were, in their very nature, light and gay, and to be too fearfully serious about it was a mistake. He did not mean to say there should not be any undercurrent of meaning in even the merest ornamentation, but it should be only an undercurrent. When it came to the surface it drew too much attention to itself. Any very pronounced meaning in design was apt to call attention to itself, and drew attention from the real object of the decoration, which was beauty. Every thinking man recognised the value of thought, and liked to find a meaning in ornament beyond its obvious purpose, but that was quite a different thing from implying, as he understood Mr. Stannus to imply, that there should be some such thought

or meaning underlying all and every decoration, in order to make it worthy of acceptance. The fact was that the literary, or historical, or symbolic intention was quite apart from art. It might be more important than art, but had actually nothing to do with it. What really wanted pointing out was, not that this literary character should be introduced into art, but the sufficiency of art even without it. Mr. Stannus had preached the doctrine of storiation very eloquently, but he did not really think there was so much necessity to preach it, because it was what every one was only too ready to accept in place of art. Every patron of art called out for a story, and would have it. What the patron of art often did not think about was the necessity of making ornament ornamental, of making decoration decorative. As to the use of asking people to tell stories, why, if they had nothing to tell, it was of no use urging them to pump up something; and, if they had anything to say, they said it of their own accord.

Mr. Hebb thought Mr. Stannus rather too much insisted on the necessity of a picture or a decoration than a story to tell. He was not so sure that that was a good thing. A decorative subject or picture should be complete in itself, and the tendency of the public to insist that it should tell of something was not a good tendency, but, on the contrary, probably a bad one. If a picture were complete in itself, it ought to require no explanation. Probably the defect of some of the most admirable pictures produced—those, for instance, by Rossetti—was that they need explanation. If Rossetti's pictures had been a little better, they would probably have needed no explanation; but he himself seemed to feel that there was something wanting in them, and therefore supplemented them by some very exquisite poetry. If Rosetti had confined himself to poetry, he would probably have been a greater poet, and if he had confined himself to decoration, he would probably have been a greater artist; but he was always aiming somehow between the two things, between literature and art, and slightly missed his mark in both. He quite agreed that everyone ought to thank Mr. Stannus for an extremely interesting and valuable paper.

Mr. H. Longden said he had heard with great interest the explanation Mr. Stannus had given of this new word. He had been curious to know what it meant, and was not yet quite convinced that the existing words in the language would not be sufficient. The paper had been extremely interesting and comprehensive. Mr. Stannus had an admirable power of qualifying things and putting them in order; and the diagram, with the different modes of classification, was very instructive. He spoke about what he should call symbolic figures and ornament in a building being necessarily, when intended to be comprehensive, of a literary character. He knew a building recently erected in which there was a good deal of symbolic decoration, both in the way of sculpture and painted glass, and was much interested to see how much knowledge had to be brought to bear to make the building thoroughly represent the idea it was intended to express. Different ages of the world had to be called upon to supply figures to represent what was meant; in fact the whole decoration was simply symbolic; and in that he took leave to differ from Mr. Day as to the use of symbolism in buildings. He considered the great triumph of a work was when the whole of it was both symbolic and ornamental. There was a little piece of work in London, which Mr. Stannus had not alluded to, which was very interesting, viz., the frieze in Cutlers'-hall, Warwick-lane, by Mr. Creswick, representing the different processes of making cutlery which was one of the best things in London. He had often noticed people standing to look at it, and his experience was that when the sculpture was out of doors and really expressed anything, people like to look at it. He had seen them examining the figures round the Wellington monument, at Hyde-park Corner, also the Gordon monument, and the subjects round his statue, and that kind of work would always draw the attention of the people, and if it were made plain and expressive would educate them.

The Chairman said he thought if they were to have any amount of storiation there were two conditions which should be observed; firstly, it should need no explanation. Abroad there had been a great deal done in the way of storiation and allegorical decoration, but even educated people required to read a whole pamphlet to understand them, and the masses did not understand them at all. In the Middle Ages there was an immense deal of storiation. The French cathedrals and Flemish Town-halls were full of storiation, in fact the Mediæval artist expressed in stone all he believed of the world of the past, present, or to come; and the people all understood it; it was their book in which they read. In old Greece it was the same, the artist simply expressed a popular language which everybody understood. The Renaissance robbed the people of art, and it became a thing for the upper classes only. What was now wanted was to make art for the people. The important thing would be that all persons called upon to decorate a building outside and inside should make their work so clear that the people should understand it. One great danger of the present day was introducing, no longer so much from Greek and Roman myths, but too much Japanese and Chinese. He was a great admirer of Japanese art, but Japanese art was no more wanted in England than Greek or Roman art; what was wanted was art that English people could understand, not educated people only, but the masses. They would not understand Japanese symbols, and what was the use of introducing these into art. In art, as in literature, one should speak to English people in their own tongue. They had all been much pleased with Mr.

Stannus's paper, to which he had given a great deal of hought, and it must necessarily also lead the hearers o think very much of the different branches of art which he had mentioned. He begged to conclude by proposing a hearty vote of thanks to him.

The vote of thanks having been carried unanimously,

Mr. STANNUS, in reply, said he was much gratified at the kind manner in which the paper had been received, and also obliged to his friends who criticised t. He quite agreed with Sir George Birdwood that he first thing in the decoration of a house was comfort, the second beauty, and the third meaning; but with regard to the homely instances given, he hought them fairly appropriate. Mr. Day assumed hat he wished to subordinate beauty to meaning, but hat was not so. His subject was not decoration, but meaning; and it must not be understood that he was ignoring the one to exalt the other; but one saw in the city of London miles of egg-and-tongue moulding; and he would give up all of that for half a dozen panels, telling something about the 19th century, which should remain there to tell the story to those hat came after. Mr. Day seemed to overlook the fact that what is now decorative had meaning before it had beauty. At any rate, meaning was the first function of ornament. In old Egyptian work, the meaning was the first thing thought of, and the idea of pleasing the eye was entirely an afterthought. He did think that ornament should have beauty. You might make a thing beautiful, but you should try to put a little meaning into it also, not have mere brush work all over the place. Would Mr. Day, for instance, have decorated the frieze round that hall with mere decorative ornament instead of Barry's paintings?

Mr. DAY said, if it were well done, he should be quite content.

Mr. STANNUS said if Mr. Day thought so, he would not argue the point further. Mr. Hebb said a picture should require no explanation, and of course that was true. When he spoke of meaning, he referred to that which lay on the surface, so that those who ran might read. He might say that he had on his note the frieze at Cutlers'-hall, but was obliged to leave it out for want of time. He came across it one day when wandering about Paternoster-row, and thought to himself that someone from Sheffield had been here. There were little details about it so thoroughly done that he was quite sure none but a Sheffielder who had seen the men actually at work could have accomplished it. It was done in *terra cotta*, and it would remain, he trusted, until the celebrated New Zealander came, and he would be able to see what Sheffield was like in this century. Mr. Longden said he was not quite convinced that existing words would not have done, but he had not given the word that would do. It was a case of the "missing word" which he had supplied, though he should be glad to have a better one suggested. The Chairman had put the matter in a very much better way than he could —the storiation should be its own explanation. Buildings in the Middle Ages were full of stories. At Rheims, Chartres, and all the grand old cathedrals there was abundant illustration of this, and even in England the subject was so large that one did not know where to begin, and could only touch the hem of it. He entirely agreed that English art should appeal to English people, and especially to the common people, but surely they might try to give them other ideas besides those belonging especially to their own country. They should know their own country, of course, but he did not agree with limiting the sympathies of the people to their own country. That was done to a nauseating extent in France, as if there were no other country in the world, and it had a cramping effect. He should like people to know everything about their own country, and also to know something about the people of other countries.

NINTH ORDINARY MEETING.

Wednesday, Feb. 8, 1893; PROF. JOHN M. THOMSON, Sec.C.S., in the chair.

The following candidate was proposed for election as a member of the Society:—

Dayol, Roberto, Mexico City, Mexico.

The following candidates were balloted for and duly elected members of the Society:—

Brown, Nicol, Sunnymeade, Muswell-hill, N.
Cowan, William James, 17, Coleman-street, E.C.
Dowden, Colonel Thomas F., R.E., care of Cox and Co., 16, Charing-cross, S.W.
Jenkin, Barnard Maxwell, 29, Whitehall-court, S.W.
King, William Henry, 34, Park-road, Haverstock-Hill, N.W.
Kipping, Percival Philip, Oxford-court, Cannon-street, E.C.
Osenton, George, jun., Westerham, Kent, and Horley, Surrey.
Spencer, Augustus, School of Art, Leicester.
Thomas, O. V., Government-house, Singapore.
Waylett, Richard Morris, 534, Oxford-street, W.

The paper read was—

ON SOME POINTS IN THE CHEMICAL TECHNOLOGY OF DRYING OILS, OIL-BOILING, AND BLEACHING.

By PROFESSOR W. N. HARTLEY, F.R.S.,
Royal College of Science, Dublin.

The invention of painting with oil originated with John Van Eyck and his brother Hubert, an eminent artist, about the year 1410. John

Van Eyck discovered that linseed oil and nut oil became capable of drying, or of hardening, when they had been boiled, and that this property was increased by the addition of certain essential oils to prepare the medium for painting.*

In the year 1832 Saussure communicated to the Annales de Chimie et de Physique, a paper on the action of oils on oxygen, at the temperature of the atmosphere (vol. 49, p. 225). After prolonged contact with oxygen, he found that the oils absorbed the gas, and produced carbonic acid and hydrogen, but in the case of drying oils the quantity of carbonic acid relative to the oxygen absorbed, was much less than with non-drying oils. He mentions a statement contained in the "Traité de Chimie" of Berzelius, vol. v., that linseed oil which has been left in a bottle exposed to air becomes thick, and yields, when mixed with alcohol, a solution which is advantageously employed in the preparation of fatty varnishes, because it toughens the resinous body of the varnish.

In 1850, Chevreul read before the Academie des Sciences his great memoir, entitled "Recherches Experimentales sur la Peinture de l'Huile." This classical investigation of a purely technical subject was preliminary to a report on painting with zinc white, and many of the facts which he established it will be necessary for me to recapitulate.

Paint, such as is used for ordinary purposes, is composed, essentially, of three materials, without taking into account the coloured pigments.

1. White lead, or sublimed zinc white.

2. An oil, generally linseed or poppy oil, which is ground up with the white lead or zinc white until it becomes a soft paste. This is mixed with variable preparations of linseed oil and spirit of turpentine.

3. A substance called dryers, or siccative material, it may be linseed oil in which litharge is dissolved, or it may be linseed oil containing a compound of manganese.

Paint owes to the dryers its property of drying more rapidly than it would do without it; and it is considered indispensable in buildings in all cases where paint, applied to wood, stone, or metal, would not be quite dry in 48 hours, or at most in 72 hours, after the first application.

The first question which requires an answer is, what chemical process takes place when a paint dries?

It was shown by Saussure that linseed oil absorbs oxygen; the same fact was proved by Liebig (*Annalen der Chemie*, vol. 33, pp. 110-115, 1840); but it was further proved by Chevreul that, when the oil contained manganese, it absorbed oxygen much more greedily; and when a manganese oil—that is to say, a boiled oil containing manganese—was mixed with linseed oil, the substance absorbed oxygen, from a limited supply of air contained in a closed space, until no trace of any other gas but nitrogen remained. The power of absorbing oxygen possessed by 100 volumes of linseed oil, compared with that of 100 volumes of a mixture of linseed oil and so-called manganese oil, was as 9·4 to 100. This may be termed the measure of its drying power. A mixture of linseed oil, with a little more than one-quarter of its volume of manganese oil, had a power of absorbing oxygen four and-a-half times greater than either of the components of the mixture taken separately. In this case, he argues that linseed oil may be considered as a "drier" to manganese oil.

Chevreul's Researches on the Influence of Litharge, Peroxide of Manganese, and of Heat on the Drying Power of Linseed Oil.

Oil, boiled with litharge, was prepared, by heating the linseed oil in a cast-iron vessel until it frothed, and, after a period—which varied from three to six hours—about 10 per cent. of its weight of litharge was added, heating being continued for six hours longer. After this, the oil was left to settle, and drawn off from all deposit.

Leclaire boiled oil by heating linseed oil alone to a high temperature for five hours, and heating it for at least eight hours longer with manganese dioxide.

It was proved that linseed oil, without any addition whatever, if boiled for three hours, became a better drying oil than it was previous to the action of heat.

Oil boiled with 10 per cent. of litharge for three hours, is a much better dryer than when heated without this oxide.

Oil boiled alone for five hours is an inferior drying oil to one heated for only three hours.

Oil previously boiled alone for five hours, and boiled alone again for three hours, is scarcely altered in drying power, but it becomes a better drying oil if it is boiled the second time with litharge. It is inferior to a

* Guignet's article, "Fabrication des Couleurs," in Frémy's "Encyclopedie Chimique."

drying oil which has been boiled only three hours with litharge, without being submitted to a previous boiling.

Oil boiled alone for five hours, boiled for a further period of three hours with manganese dioxide, which has already been used for one operation, is very nearly as strong a dryer as that which has been boiled with litharge under the same conditions ; but it is superior to an oil which has been boiled with manganese dioxide for eight hours. This no doubt arises from the longer boiling with manganese having caused a larger quantity of manganese to dissolve, and that the quantity dissolved is in excess of that which yields the best result.

Finally, oil boiled for five hours, and then boiled alone once more for eight hours, becomes viscous, and the first coat requires a considerable time to dry. We thus see that the oxide of lead and of manganese in certain proportions concur with heat in increasing the drying power of linseed oil. Barruel and Jean very carefully investigated the action and light upon drying oils mixed with certain metallic salts, and established in a certain degree the fact that the drying of oils is a process of slow oxidation. (*Comptes Rendus*, vol. 26, pp. 577 to 580, 1853).

The following points in Chevreul's paper appeared to be difficult of satisfactory explanation, and suggested to my mind an examination *de novo* of the facts, as well as an investigation of the chemistry of the subject generally :—

1. Linseed oil not boiled acted as a dryer to the same oil boiled with manganese dioxide.

2. Linseed oil, boiled with either litharge or manganese, dried more rapidly when mixed with turpentine.

3. Oil, mixed with white lead, zinc white, antimony white, and arseniate of tin, act differently, thus :—The white lead dries most rapidly, the zinc white next, but antimony white and arseniate of tin are incapable of acting as dryers, in fact, they retard the drying process.

4. Oil boiled alone for five hours, and boiled for a further period of three hours with manganese dioxide became a superior drying oil to one which had been boiled with manganese dioxide for eight hours.

In 1889, I commenced a series of experiments, which were continued for two years, on twenty-five weighed quantities of raw linseed oil, to which given weights of manganese compounds, dissolved in oil, were added. Each quantity was treated in a different manner ; the temperature to which it was heated, and the time that it was submitted to the action of heat, were carefully recorded. The same quantity of each oil was spread over a given surface of glass, and the time which it required to set and to dry was recorded, and the colour, transparency, and general appearance of the films were noted. The oils were then kept for six days, and again submitted to a similar trial. A second series of observations was then made, in order to verify the first, and a standard measure of tackiness was applied to each sample as it set and gradually dried. A portion of each sample was then mixed with white lead and with zinc white, the same weight of each pigment being added to a given weight of oil. The paints were used to cover a surface of glass and of deal, the same superficial area being covered as far as possible by each sample. Samples of the best of these specimens were mixed with a given proportion of turpentine, and the drying power of the mixtures, both with and without admixture of zinc white and white lead, were painted on glass, and the result in each case noted. In all there were about 250 experiments, the voluminous detailed account of which I propose to omit, and merely state some of the conclusions arrived at.

1. The chemical action of a manganese compound when dissolved in linseed oil, is that of a carrier of oxygen from the atmosphere to the oil. Manganese oxide takes up oxygen from the air, and transfers it to the oil, and in so doing it suffers alternately the opposite processes of oxidation and reduction.

2. To obtain the best result, the amount of manganese present must not exceed a certain small proportion of the oil.

3. Oil to which turpentine has been added dries more rapidly than oil without such addition, because the oil being diluted and rendered thinner, it spreads over a larger surface, and is in contact, therefore, with a much larger quantity of oxygen.

4. Turpentine does not act as a dryer, that is, as a carrier of oxygen to linseed oil.

5. Different white pigments behave differently when drying, because the more powerfully basic the properties of the pigment, the more powerful is its action as a dryer. Lead oxide and white lead (basic lead carbonate) combine more easily with the acids of linseed oil than zinc oxide does. But zinc oxide dries better than antimony oxide, because it is a stronger base, while arseniate of tin has no

basic properties, therefore does not act as a dryer.

Different substances, that is to say, those without chemical action on oil, such as lamp-black, sulphate of baryta, and sulphate of lead, cannot act as "dryers."

The Composition and Constitution of Linseed Oil.

Linseed oil has been shown by Mulder to be a glyceride of a peculiar acid, called linolëic acid. According to the recent analysis of K. Peters, linolëic acid has the composition $C_{18}H_{31}O, OH$; so that the composition of the glyceride would be represented by the formula—

$$\left.\begin{matrix}(C_{18}H_{31}O)3\\ C_3H_5\end{matrix}\right\} O_3$$

By saponification it yields glycerine $\left.\begin{matrix}F_3\\ C_3H_5\end{matrix}\right\} O_3$
and a salt of linolëic acid........

Linolëic acid is a thin fluid oily liquid, of a slightly yellow colour, with a high refractive power and feebly acid properties. It is insoluble in water, but dissolves in alcohol and ether easily. Its specific gravity at 60° F. is 0·9206. It does not solidify at 0° F.

It absorbs oxygen from the air very freely, to the extent of about two per cent. of its weight, and becomes tacky and viscid; finally it changes to a sort of varnish which, in thin layers on wood, dries, but on glass it only sets, and remains tacky.

It readily forms salts which are difficult to obtain in a state of purity since they decompose with the formation of acid salts. Peters has shown that linolëic acid is related to stearic acid $C_{18}H_{35}O·OH$, into which it may be converted by hydrogenising substances, such as, far instance, by the action of phosphorus and hydriodic acid. (*Journal Chemical Society*, abstracts, vol. 52, p. 126).

Whatever the exact constitution of linolëic acid may be, it is certain that linseed oil for the most part is composed of trilinolëin, though Mulder states that in addition it contains triolëin, trimyristin, and tripalmitin.

Raw linseed oil contains the following constituents:—

1. Glyceride of linolëic acid or trilinolëin.......... $\left.\begin{matrix}C_{18}H_{31}O\\ C_3H_5\end{matrix}\right\} O_3$.
2. Water.
3. Mucilage, with the composition $n(C_6H_{10}O_5)$. On boiling with dilute acids this yields a gum and a sugar.
4. An essential oil. It is present in minute proportions, and its composition is not known.
5. A mixture of colouring matters of intense tinctorial power, viz., blue and yellow chlorophylls and erythrophyll.

The only useful and desirable substance is the trilinolëin.

The relationship of linolëic to linolic and linolenic acids, and to stearic acid, will be made evident by the following formulæ:—

Linolëic Acid.
$C_{18}H_{31}O·OH$.

Stearic Acid.
$C_{18}H_{35}O·OH$.

$$\left.\begin{matrix}\text{Linolëic Acid}\\ \text{(a mixture).}\\ C_{18}H_{31}O·OH.\end{matrix}\right\} \begin{matrix}\text{consists}\\ \text{of}\end{matrix} \left\{\begin{matrix}\text{Linolic}\\ C_{18}H_{32}O·OH \text{ and}\\ \text{Linolenic}\\ C_{18}H_{30}O·OH.\end{matrix}\right.$$

The Effect of Oxidation on Linseed Oil.

It has been shown by Cloez (*Comptes Rendus*, vol. 61, pp. 236-239, 321-325, and 981-984; *Chemical News*, vol. 11, p. 136) that the effect of oxidation upon linseed oil is to destroy all the glycerine, and to produce therefrom carbonic, formic, and acetic acids, together with some acrolein. When boiled at a high temperature without the addition of any metallic oxide, the glyceride is decomposed, acrolein is formed, and linolëic acid set free. In fact, whether oil is oxidised by air, by metallic oxides, or whether it be simply heated, the action in each case first leads to the destruction of the glycerine and the liberation of linolëic acid. But linolëic acid very readily absorbs oxygen, and the oxidised substance becomes a tough elastic solid, which is essentially a varnish.

In fact, the processes which an oil undergoes in drying is not dessication, or depriving it of moisture or of glycerine, but solidification, and the technical term "drying" is a misnomer. That, however, is of little consequence if we really know what is the chemical action of the "drying" process. According to Mulder, the effect of a high temperature on linoleic acid is to convert it into an anhydride, which he called linoxyn. Later researches lead to the conclusion that the fatty acid is polymerised. But here it may be stated that when oxidised even at a low temperature, it is certain that the glycerine is destroyed, and that oxidised products form a tough varnish, but it is by no means evident that they consist of linoxyn, and in this connection there is scope for some original investigation.

There are various methods of converting linseed oil into a drying oil or varnish.

1. Heating it to a high temperature with litharge.

2. Heating with red oxide of lead.

3. Heating with metallic lead.

4. Heating to a high temperature with manganic oxide.

5. Heating with manganese borate.

6. Heating with manganese oxalate.

7. By the joint action of air and heat upon the oil and manganous oxide, or a solution of manganese dioxide or manganous oxide in the oil.

In the processes 1, 2, 3, there can be no doubt that a lead of linolëic acid is produced, and that this facilitates further oxidation in air, by forming salts with some of the acid products of such oxidation, while the oxidation of the linolëic acid continues. Meeting with red lead favours oxidation by the compound itself conveying oxygen to the oil. In the case of metallic lead, it must be noted that the metal is dissolved. Chevreul has shown that, under certain circumstances, metals become dryers to oils ; thus he proved that sheets of metallic lead are capable of acting as dryers to linseed oil. Livache has carefully investigated the chemical action of oils on lead, copper, and tin, when in a state of very fine division (*Comptes Rendus*, vol. 96, pp. 260-263 ; and vol. 102, p. 1167). The lead was precipitated either as very small crystals or powder, from a solution of a lead salt in water by metallic zinc ; it was moistened with oil, and exposed to air. An increase in weight was rapidly caused, the increase was more rapid the more the nature of the oil was that of a drying oil, and it was approximately proportional to the increase in weight of the respective fatty acids contained in the oils when they were exposed to the air for a long time. The tabulated statement (next column) explains itself.

It will be seen that linseed oil is pre-eminent in its capacity for absorbing oxygen. This action of metallic lead as a dryer is due to the metal becoming oxidised at the expense of the glycerine of the oil, and so passes into solution by combining with the linoleic acid, or with acetic or fornnic acid, caused by the oxidation of the glycerine. It is the destruction of the glycerine with concurrent oxidation of the fatty acid, which causes the drying or hardening of the oil.

Livache has further investigated the acceleration of the oxidation of drying oils, and has shown that when a drying oil which has been treated with metallic lead, or with litharge, is shaken up with a solution of zinc sulphate, all the lead is precipitated from the oil, and zinc passes into solution therein. By manganese sulphate or copper sulphate the lead is removed by manganese or copper. Oil charged with lead dries in 24 hours, when spread out in a thin layer on glass ; it will dry completely in 5 or 6 hours, if charged with manganese ; in 30 or 36 hours, with copper, zinc, or cobalt ; and it requires more than 48 hours with nickel, iron, chromium, &c.

EXPERIMENTS ON THE OXIDATION OF OILS. (LIVACHE.)

Oils in Contact with Lead.	Increase in Weight.		Increase in Weight in Corresponding Fatty Acids, exposed to Air for 8 months.
	After Two Days.	After Seven Days.	
	Per Cent.	Per Cent.	Per Cent.
Linseed	14·3	—	11·0
Walnut	7·9	—	6·0
Poppy	6·8	—	3·7
Cotton-seed	5·9	—	0·8
Beech-nut	4·3	—	2·6
Colza	—	2·9	2·6
Sesame	—	2·4	2·0
Earth-nut	—	1·8	1·3
Rape	—	2·9	0·9
Olive	—	1·7	0·7

Although solidification of a drying oil charged with manganese takes place in from 5 to 6 hours, when spread in thin films, the solidification of thicker films requires a longer time. A temperature of 122° to 140F. accelerates the oxidation of the drying oils, partly because the oil becomes more fluid, and partly because the oxygen is more active at a higher temperature. Hence oil, which has been mixed with an equal volume of turpentine, or a light hydrocarbon, such as benzene, dries, as I have already explained, more rapidly than oil without such admixture.

When a boiled oil, prepared with manganese, is dissolved in an equal volume of benzene, and shaken up with air in a bottle, rapid absorption of oxygen occurs, especially about 120° F. If fresh air is repeatedly provided, the oxidation is sufficient to cause the liquid to become thick, and, on distilling off the sapient, a perfectly dry and elastic solid remains.

It is evident that an oil containing manganese is a very superior drying oil to one which has been prepared with lead.

This fact, however, is to be noted, that though a large proportion of manganese in an oil may hasten its drying, yet it is disadvantageous, because it does not form so tough a film. This arises from the film becoming hard upon the surface, and so protecting the oil underneath from absorbing oxygen from the air. The same conclusion has been arrived at by G. A. Buchheister, and is stated in the *Oil, Paint, and Drug Reporter*, in an article on "Dryers," translated trom the *Drog Zeitung*, April, 1889.

Livache also noticed that, though the oils containing large quantities of dryers dried, they afterwards lost weight, and became viscous under the same conditions.

Buchheister has shown that pure linoleates of lead and of zinc are not dryers; but if heated until it has turned brown, or begun to blacken, a lead dryer becomes effective, although it contains less of the lead componnd.

In this case, some compound of lead is formed by absorption of oxygen which either itself actually oxidises or causes the oxidation of ordinary linseed oil.

Having treated of the materials used for producing boiled oil, and of their action upon the oil, let us now consider how the operation is brought about.

Process 1.—Oil is boiled at a high temperature, that is to say, it is heated until frothing and bubbles of gas escape, when litharge or a manganese compound is added.

Process 2.—Oil is boiled at a steam heat, with litharge or a manganese compound, in conjunction with a blast of air.

Process 1.—The chemical action in the first process is doubtless one which takes place in three stages. It commences by depriving the oil of water; in the second stage it destroys the mucilage, by charring it; in the third, it destroys, in part, the glycerine, and sets free the fatty acids. After the litharge or manganese compound is added, there is formed in the oil a solution of lead salts of the fatty acids, or a manganese salt of the fatty acids.

The oil then, at the high temperature, loses glycerine by oxidation caused by the air, such oxidation being greatly facilitated by the presence of manganese compounds, which are repeatedly oxidised by the air, and reduced by the oil, that is to say, they absorb oxygen and pass it over to the oil with great facility.

It matters little, so long as the ultimate action is oxidation, what salt of manganese or what oxide is used, if it be capable of undergoing processes of an alternate character called oxidations and reductions.

It is, however, certain that some manganese compounds are more suitable than others, owing to their more or less complete solubility in the oil, and their more readily undergoing the two different processes of oxidation and reduction in presence of air and of oil.

Process 2.—The credit of being the first to boil oil without resorting to the dangerous expedient of using an open fire, and a high temperature in the manufacture, is due to Mr. Charles Vincent. He used manganese compounds, or both manganese salts and litharge. An excellent description of the method of boiling oil for the manufacture of printing inks is given in the last edition of Muspratt's "Dictionary of Chemistry." With some modifications in technical details this process is carried out on a large scale at the present time in the preparation of ordinary boiled oil. The essential parts of the plant were a steam-jacketted close boiler, with agitating gear, and a pipe for conducting a current of air into the oil by means of a blowing engine. From the head of the boiler there passed a funnel under the back of the furnace fire, by which the disagreeable products of the chemical action were conducted to a place where they were destroyed. These products, as already mentioned, are volatile fatty acids and acrolein.

Oil boiling as ordinarily carried out, is conducted by means of litharge along with compounds of manganese; in some processes these are mixed with salts of alumina and zinc. The oil so produced is brown and not clear, but it is clarified by keeping. Many samples of such boiled oil deposit insoluble matter when stored for some time, even although they may have become clear previously. This is not a desirable property. Sometimes rosin is added to hasten its drying.

Defective Properties in Boiled Oil.

The defects to be noticed, even in the best samples of boiled oil, are the following:—

1. The oil causes a brownish or yellow colour to be communicated to white lead or zinc white.

2. The oil darkens pigments containing brilliantly coloured metallic sulphides, such as vermillion, cadmium yellow, and ultramarine blue.

3. Delicate colours are darkened by the oil

when exposed to ordinary town air, that is to say, air which is not quite pure. This is the case even when the oils themselves may not injure the paints.

The causes of such alterations is, in nine cases out of ten, the use of lead dryers. This has been pointed out in the *Oil and Colourman's Journal*, No. 1, 1889, p. 1071.

1. In the first place, boiled oil which contains litharge or other lead compounds takes a permanent brown colour, which affects the purity of white lead, zinc white, and delicate pale tints.

2. Lead forms, with extreme ease, lead sulphide, which, in very minute proportions, is yellow or brown; in larger quantity its colour is black. The lead sulphide is readily formed by contact with other sulphides, as, for instance, vermilion, cadmium yellow, and ultramarine.

3. Boiled oil, containing lead, is coloured brown by exposure to air, owing to the presence of minute quantities of sulphuretted hydrogen, which causes the formation of lead sulphide.

The remedy is obvious: no oil should be used which has been boiled with dryers containing lead. In other words, oil should be boiled with pure manganese compounds only.

How to Test for Lead in Boiled Oils.

In cases where it is desirable to have information of the presence or absence of lead in a boiled oil, the following test will be found most useful:—A mixture is made of four ounces of glycerine with an ounce of ammonium sulphide, the liquid being kept in a stoppered bottle. Or glycerine is mixed with an equal volume of water, and saturated with sulphuretted hydrogen. Half an ounce of the oil to be tested is placed in a white basin, with the addition of two or three drops of the glycerine solution. The two liquids are thoroughly incorporated, by stirring with a strip of glass. A brown or black colour, which gradually appears, indicates the presence of lead. A pure manganese oil simply becomes slightly yellow. It is true that, if iron is present, a black colour might appear, but iron is also an undesirable impurity. Should it be required to ascertain that the colouration is or is not caused by iron, two or three drops of glacial acetic acid may be stirred into the oil, when, if the black colour remains, it is certainly not caused by iron.

Several samples of the best boiled oil, including the principal makes of pale boiled oil, have been examined by this test, with the result that they were found in every case to contain more or less lead, thus:—

Sample A (Brown Oil). — Turned quite black very rapidly. Contained much lead.

Sample B (Brown Oil). — Turned quite black very rapidly. Contained much lead.

Sample C (Brown Oil).—Turned very dark brown slowly. Contained much lead.

Sample D (Pale Boiled).—Turned dark brown. Contained lead.

Sample E (Pale Boiled).—Turned brown slowly. Contained a small proportion of lead.

The utility of this test may be understood, when I mention the fact that it enabled me to detect the cause of the discolouration of the interior of a building which had been ordered to be painted with zinc white. The colour was never quite so white as it should have been, because a brown oil was used. After a period of two or three years the discolouration became more marked, until at last the paint assumed a uniformly dirty appearance. When a sample of the oil used was examined by this test, it was found to contain lead.

Here it may not be out of place to remark that, under the old process of oil-boiling at a high temperature, the brown colour of the oil was, to some extent, an indication that the oil had been sufficiently heated—that is to say, properly boiled; but in the modern processes so largely used, in which oxidation is aided by a blast of air, this colouration is no indication whatever of the excellence of the oil; it may be, in fact, the very reverse.

This fact appears to be unknown, or, at any rate, is not a matter of common knowledge among practical men in this country, who, being uninformed as to the methods of preparing the oils, consider that a brown colour is desirable, if not essential.

Hence, in a specification of C. Binks, now thirty years old, it is stated that the objects of the invention are, firstly, to improve the drying properties of linseed oil; secondly, to obtain such drying oils in certain cases free, or comparatively free, from the deep or dark colour usually pertaining to linseed oil; thirdly, to provide improved methods of obtaining dark coloured drying oils similar in appearance and uses to those known as boiled oils. From which it appears that, in order to meet the prejudices of customers in favour of dark oils, he actually provides a means of darkening and spoiling an oil of superior manufacture.

When oil-boilers were compelled to adopt some expedient to give a reddish-brown colour to the oil, they added a small amount of litharge, the introduction of which actually spoils the oil, and makes it unsuitable for

many purposes to which it is otherwise applicable. (See article "Oil, Boiled Linseed," in Muspratt's "Dictionary of Chemistry," p. 472.) Of late years, pale boiled oils have been more largely manufactured for special purposes. It is obvious that, for decorative house painting, in which delicate tints are a leading feature, they may be advantageously employed.

For, notwithstanding that some of the brown oils, when mixed with white lead, do not entirely retain the brownish tint, but, to some extent, lose it upon drying, yet they never preserve the whiteness of white lead. It follows, therefore, that a pale colour in the oil, provided it is not the yellow colour of raw oil, it greatly to be preferred. Moreover, when paints are mixed with zinc white, no trace of lead should be contained in the oil, otherwise, one of the valuable properties of zinc white pigments is destroyed, namely, its power to retain its whiteness in the atmosphere of a town, because its colour is not affected by sulphuretted hydrogen.

Very generally, zinc white and white lead paints are not mixed with drying oils, but with refined linseed, or bleached, oil. This, at any rate, is the practice on the Continent. That is to say, the pigments are mixed with an oil from which the impurities, and the natural yellow and red colouring matter, have been removed, so that the colour of the paint is white. If ordinary oil be used, the paint is more or less yellow. In order to render such paint quick drying, a certain amount of dryers, in a solid or liquid form, is added. These dryers almost invariably contain lead, so that zinc white paint is contaminated by lead in another way, which may not be suspected, or which is overlooked.

One of the striking features of the process of oil-boiling is the disengagement of very pungent and irritating vapours. These consist of formic and acetic acids, with a small proportion of acroleïn, all of which result from the oxidation of glycerine. Acroleïn is the aldehydes of acrylic acid, and it may be very readily oxidised by air; it is, therefore, by no means difficult to destroy it.

Its composition is C_3H_4O, and it is formed from glycerine, by the removal of the elements of water. Thus:—

$$\begin{array}{lclcl} CH_2{\cdot}OH & & CH_2 & & \\ \;| & & \;\| & & \\ CH{\cdot}OH & = & CH & + & 2\,H_2O \\ \;| & & \;| & & \\ CH_2{\cdot}OH & & CHO. & & \\ \text{Glycerine.} & & \text{Acroleïn.} & & \end{array}$$

Even the heating of any fat or fatty oil to a high temperature causes this decomposition to take place.

The acid substances formed by oxidation are

Formic Acid	$H{\cdot}COOH$.
Acetic Acid	$CH_3{\cdot}COOH$.

On Dryers and their Chemical Action on Oils.

A dryer or siccative material is any compound which is added to linseed oil, or to an oil paint, to hasten the drying of the latter.

Among these may be mentioned, metallic lead, litharge, a mixture of litharge and manganese sulphate, of lead and manganese nitrate, red lead, lead acetate, lead linoleate, manganese borate, manganese dioxide, manganous hydroxide, manganese oxalate, manganese oleate, and manganese linoleate. These are mixed sometimes with anhydrous zinc sulphate or zinc acetate, or with dried alum. Some of these substances are only effective when heated with the oil.

The Action of Salts of Zinc and Alumina in Oil Painting.

Let us consider, first, the action of salts of zinc and alumina. Raw oil contains water and mucilage; the former can be absorbed by anhydrous zinc salts and by dried alum, and solutions of the salts and the salts themselves are capable of precipitating mucilage from the soil; hence these substances cause the impurities to become insoluble, so that that they are carried down as "foots." Heat greatly facilitates this action, particularly by causing the oil to become more fluid, and by the action of the anhydrous salts, water is withdrawn from the oil. On the drying, or, more correctly speaking, on the oxidation of the oil, they exert no chemical action whatever. It has been shown, by G. A. Buchheister, that zinc linoleate and lead linoleate do not act as dryers, when simply added to the oil; he has also shown that, though the former is soluble in hot oil, it is insoluble in cold oil, and it therefore separates from the oil as it cools. The latter is very soluble in linseed oil, but only adds to its drying power when heated therewith.

The Action of Metallic Lead Salts in Oil-boiling.

Taken in conjunction with a high temperature, lead dissolves in oil at the expense of

the glyceride which is decomposed into acroleïn, while lead linoleate is formed. Thus, as we have seen by the action of heat and of dehydrating substances, glycerine itself is decomposed into acroleïn and water :—

$$\begin{array}{c} CH_2\cdot OH \\ | \\ CH_2\cdot OH \\ | \\ CH_2\cdot OH \\ \text{Glycerine.} \end{array} = \begin{array}{c} CH_2 \\ \| \\ CH \\ | \\ CHO. \\ \text{Acroleïn.} \end{array} + \begin{array}{c} H_2O \\ \text{Water.} \end{array}$$

In a manner somewhat similar linseed oil is decomposed by lead into acroleïn, and lead linoleate in presence of air. It is here suggested that this action may be explained by the following equations :—

$$2\left\{\begin{array}{l} CH_2\cdot OC_{18}H_{31}O \\ \| \\ CH\cdot OC_{18}H_{31}O \\ \| \\ CH_2\cdot OC_{18}H_{31}O \end{array}\right\} + 3\ Pb. + O.$$
$$\text{Trilinoleïn.}$$

$$2\left\{\begin{array}{l} CH_2 \\ \| \\ CH \\ | \\ CHO \end{array}\right. + 3\ Pb. \left\{\begin{array}{l} OC_{18}H_{31}O \\ OC_{18}H_{31}O \end{array}\right. + H_2O.$$
$$\text{Acroleïn.} \qquad \text{Lead linoleate.}$$

When litharge is heated with linseed oil, the action is somewhat similar, the substances formed being acroleïn, lead linoleate, and linoleïc acid, thus :—

$$\left\{\begin{array}{l} CH_2O\cdot C_{18}H_{31}O \\ | \\ CHO\cdot C_{18}H_{31}O \\ | \\ CH_2O\cdot C_{18}H_{31}O \\ \text{Trilinoleïn.} \end{array}\right. + \begin{array}{c} PbO = \\ \text{Litharge.} \end{array}$$

$$\left\{\begin{array}{l} CH_2 \\ \| \\ CH \\ | \\ CHO \end{array}\right. + Pb\left\{\begin{array}{l} O\cdot C_{18}H_{31}O \\ O\cdot C_{18}H_{31}O \end{array}\right. + HO\cdot C_{18}H_{31}O$$
$$\text{Acroleïn.} \qquad \text{Lead linoleate.} \qquad \text{Linoleïc acid.}$$

If we consider the action of red lead on trilinoleïn, we have not only the formation of these lead linoleates, but an excess of oxygen available for the oxidation of glycerine to acrolein and acrylic acid, or to acetic and formic acids.

These equations serve to show the effect of lead and lead oxides in what may be termed the initiation of the chemical action upon the oil. Subsequent changes, no doubt, depend upon the conditions which obtain at the time, notably upon the temperature and upon access of air to the oil. It is probable that acid linoleates are formed, and that compounds formed from the polymerisation of linoleïc acid result eventually.

The Action of Lead Linoleate and Lead Acetate in Oil-Boiling.

It has already been mentioned that Buchheister could not find any chemical action caused by the presence of lead linoleate in oil, unless it is heated to a high temperature, and then it certainly appears to act as a dryer. The same is correct when stated of lead acetate; but if this latter salt be heated in oil, probably some lead linoleate is formed, and acetic acid liberated.

The Action of Manganese Compounds on Oil-Boiling.

Whatever doubt there may be as to the action of lead salts, there can be none whatever as to that of manganese compounds. In the first place, manganous oxide is a powerful base, which readily dissolves in oil; manganic oxide is also readily soluble, yielding fatty acid salts of manganese, and causing oxidation of glycerine. Manganese borate, and manganese oxalate are both soluble in oil, the former much more readily than the latter, but they are both salts of little stability at high temperatures in contact with oils. They both dissolve, by the aid of heat, forming fatty acid salts of manganese. Borate liberates boric acid under these circumstances, but oxalate yields a mixture of carbon monoxide and carbon dioxide.

Of manganese oleate and linoleate nothing more may be said than that both are extremely soluble in oil, and both easily oxidised from colourless to brown compounds when submitted to the action of air.

What is it that Constitutes a Drying Oil?

Much important work has recently been published, which throws a light upon the chemical structure of the acids which enter into the composition of drying oils.

Alexander Saytzeff obtained dihydroxystearic acid from oleïc acid by oxidising it with potassium permanganate in an alkaline solution.

Dieff and Reformatsky examined ricinoleïc and linoleïc acids in the same way, and obtained from the former, trihydroxystearic acid, and from the latter, tetrahydroxystearic acid. (*Berichte Deutschen Chem. Gesell*, vol. 20, p. 1211.)

K. Hazura, in the same manner, investigated chanvroleïc acid (from hemp oil) and linoleïc acid, and proved the two to be of similar con-

stitution, if not identical. (*Monatschrift für Chemie*, vol. 7, p. 637—loc. cit., vol. 8, pp. 147-156.)

Hazura and Friedreich examined poppy and nut oils, with the result that the acid of each has been identified with linoleïc acid. (*Monatschrift für Chemie*, vol. 8, p. 156-165; *Bulletin de la Société Chimique*, vol. 48, pp. 367 and 516.)

Subsequently Hazura proved that linoleïc acid consists of two substances, one of which he termed linolic, and the other, linolenic acid. (*Monatschrift für Chemie*, vol. 8, p. 260-271; *Bulletin de la Société Chimique*, vol. 49, p. 140.)

Chanvroleïc acid was identified with linolic acid, hence this acid is contained in poppy, hemp and nut oils. The following are the principal drying oils, and the substances which confer upon them the property of drying or hardening under oxidation:—

Castor oil	contains	ricinoleïc acid.
Nut oil	,,	linolic ,,
Hemp oil	,,	linolic ,,
Poppy oil	,,	linolic ,,
Sunflower oil	,,	linolic ,,
Linseed oil	,,	linolic and linolenic acids.

The products of the oxidation of linolic acid are sativic and azelaic acids or sativic acid only. Under the same conditions linolenic acid yields an acid called linusic. Now sativic acid is a tetrahydroxystearic acid, and linusic acid is hexahydrosystearic acid, accordingly in the following tabulated statement the relationship of these acids is made apparent. It will also be seen that the non-saturated fatty acids, when oxidised with a solution of alkaline potassium permanganate combine with as many hydroxyls as their carbon atoms are free to unite with, and are thereby converted into saturated hydroxy acids containing the same number of carbon atoms as the original molecules from which they were derived:—

Unsaturated Acids.				Saturated Hydroxystearic Acids.		
Linolenic	Acid ..	$C_{18} H_{30} O_2$	yields	hexhydroxystearic	Acid ..	$C_{18} H_{30} O_2 (OH)_6$
Linolic	,, ..	$C_{18} H_{32} O_2$	,,	tetrahydroxystearic	,, ..	$C_{18} H_{32} O_2 (OH)_4$
Ricinoleïc	,, ..	$C_{18} H_{33} (OH)O_2$	,,	trihydroxystearic	,, ..	$C_{18} H_{33} O (OH)_3$
Oleïc	,, ..	$C_{18} H_{34} O_2$	,,	dihydroxystearic	,, ..	$C_{18} H_{34} O (OH)_2$
Eläidic	,, ..	$C_{18} H_{34} O_2$	,,	dihydroxystaaric	,, ..	$C_{18} H_{34} O (OH)_2$

C. Michael and A. Saytzeff obtained a compound which they regard as the anhydride of hydroxystearic acid, with the composition $C_{36} H_{68} O_4$, or

$$\begin{array}{l} O—C_{17} H_{34}—CO \\ \,| \qquad\qquad\quad\;\; | \\ CO—C_{17} H_{34}—O \end{array}$$

(*J. fer Prak. Chemie* (2), vol. 35, p. 369); (*Bull. Soc. Chimique*, vol. 48, p. 516).

When an oil is boiled, undoubtedly hydroxy-acids, or their anhydrides, are formed; and most likely the substance termed by Mulder *linoxyn* is an anhydride of similar type, as regards constitution, to that obtained by Michael and Saytzeff; but, instead of being produced from a dihydroxy acid, probably of more complex structure, being the result of a greater degree of oxidation.

The Constitution of Unsaturated Acids.

Probable Formulæ.

Oleïc acid.	Ricinoleïc acid.	Linolic acid.	Linolenic acid.
CH_3	CH_3	CH_3	CH_3
|	|	|	|
$(CH_2)_{13}$	$(CH_2)_{13}$	$(CH_2)_{13}$	$(CH_2)_{12}$
|	|	|	|
CH	CH	CH	CH
‖	‖	‖	‖
CH	CH	C	C
|	|	‖	‖
CH_2	CH_2	CH	C
|	|	|	‖
COOH	COOH	COOH	CH
			|
			COOH

According, however, to the latest work of Reformatsky (*Jour. Chem. Soc.*, vol. 58, p. 362), it is an open question whether linoleic acid is really a heterogenous substance, as Hazura states it to be, since he could only obtain tetrahydroxystearic acid therefrom.

Adulterants of Linseed Oil and of Boiled Oil.

The chief adulterants are cotton-seed oil, rosin oil, and linoleïc acid. It has been shown by Livache (*Comptes Rendus*, vol. 96, p. 260) that cotton seed, which is to some extent a drying oil, can act as such when mixed with linseed, but that when added to olive oil, it behaves as a non-drying oil. In fact, its behaviour is anomalous, and of such a character that it greatly facilitates its extensive use as an adulterating material for the more expensive oils. In my own experience, a linseed oil of high repute has been found to contain a considerable quantity of what appears to be cotton-seed oil, although sold as linseed and this has been converted into drying oil; but had pure linseed oil been operated upon by the same process, the resulting product would have possessed much more satisfactory properties. I have likewise had

samples of linseed oil adulterated with rosin oil, a deleterious adulterant, but one which may be more readily detected than cotton seed oil. Rosin is added to boiled oil to hasten its drying; this also is an injurious substance. Of late years glycerine has become an article of greater value than formerly, and this may account for the manufacture of linolëic acid and its use as an adulterant of olëic acid, as shown by M. Ferdinand Jean; and as an adulterant of linseed oil, as the analyses of Prof. Wefer Bettink indicate. The latter case is very instructive. A sample of linseed oil was found to conform to the standard of purity at present laid down, but it turned out to be perfectly useless for painting purposes, as when mixed with white lead the paint became brittle in a few hours. There was found to be free linolëic acid to the amount of 34 per cent. present in the oil which must have been wilfully added. (*The Analyst*, vol. xv., p. 79.)

Lastly, it may be mentioned that certain samples of "pale boiled oil" have been found to contain what is practically a raw oil mixed with dryers. Although such oils will dry, their efficiency is nothing like so great as that of an oil "boiled" with a blast of air at a suitable temperature, and, moreover, such oils are deficient in body.

On the Bleaching of Oils.

In treating of the bleaching of vegetable oils, it is necessary to consider the nature of the colouring matters contained naturally in such oils. These consist of a mixture in varying proportions of the colouring matters known to exist in the leaves of plants, but which, in the case of oils, are derived from the fruit, such as olives, or seeds, such as linseed, from which the oils are expressed. There can be no doubt that these substances are closely allied in chemical constitution; they all possess an intensely powerful colouring property, by which I mean, that though the colour of some of them may not be dark, yet a very minute weight is capable of imparting a tint to a very large quantity of material.

The names of these substances are:—

Xanthophyll—yellow.
Yellow chlorophyll—yellow.
Blue chlorophyll—blue.
Erythrophyll—red.

In some oils only the xanthophyll and yellow chlorophyll are present; in others, such as olive oil, the yellow and blue chlorophylls occur, and give the liquid a green tint, while in linseed erythrophyll is always present with more or less of the yellow and blue chlorophylls, and some xanthophyll. According to the different proportions of these colouring matters the oil varies in colour. For instance, linseed oil, when brown, contains a mixture of erythrophyll with yellow and blue chlorophylls; when greenish brown, the yellow and blue chlorophyll are present in somewhat larger proportion, but mixed with erythrophyll; while, generally speaking, a bright yellow or pale yellow oil contains xanthophylls only. These substances appear to be combined with the oils, or to be substances of a fatty nature. They are neither dissolved nor acted upon by water, nor by acids diluted with water, when naturally contained in the oils. They are freely soluble in alcohol, and an alcoholic solution is not only susceptible of being destroyed by the joint action of air and water, but by very dilute aqueous solutions of mineral acids, and by acetic acid. In aqueous and alcoholic solutions, light speedily modifies the blue, and eventually destroys all these colours. A solution in turpentine of the isolated colouring matters is also easily destroyed. But, on the other hand, a solution of the colours in melted paraffine wax is comparatively stable.

Zinc hydroxide, copper hydroxide, baryta, potash, and soda easily combine to form metallic salts with blue chlorophyll, less readily, though readily enough with yellow chlorophyll, but far less readily with xanthophyll and erythrophyll. The following facts will serve to show that this is the case. When a solution of the colouring matters contained in green leaves is made by extracting dry, but freshly-gathered, leaves with absolute alcohol, an addition of a saturated solution of baryta water, added to the intensely green extract, precipitated at first the compound of blue chlorophyll with baryta, then a further addition precipitates the yellow chlorophyll, also as a baryta salt; but xanthophyll and erythrophyll either remain in solution, or require a much larger addition of the base in order to be precipitated. A crystalline compound of blue chlorophyll with soda has been obtained by Guignet, which is comparatively stable. This substance is, no doubt, formed in green vegetables when they are boiled in water to which some carbonate of soda has been added, to maintain their fresh appearance. The addition of a small trace of copper sulphate to peas and to pickles forms a very permanent copper compound with the colouring matter, which gives an attractive appearance to these articles. Such being an outline of the chief chemical proporties of the

natural colouring matters contained in oils, the facts mentioned will serve to render the processes for removing the colour from oils more intelligible than they otherwise would be.

Vegetable oils are decolourised, either partially or completely, by the application of one of the following agents, or chemical processes:—

1. By the action of light, or by the joint action of light and air.

2. By acids.

3. By saponification.

4. By the action of chlorine.

1. By exposiug raw linseed oil to the action of sunlight, it slowly becomes pale in colour, and finally colourless. It is in the highest degree probable that as oxygen is absorbed by the oil and acids, substances are thereby produced, that these acids effect the destruction of the colouring matters. In such wise castor oil is bleached.

2. By treating linseed oil with moderately strong sulphuric acid, as in the process of refining the oil, first proposed by Thénard. As the oil and sulphuric acid are of very different specific gravities, it is essential that they be very rapidly and thoroughly mixed by violent agitation. The impurities, such as mucilage and albumenous matters are thus deprived of water, and more or less charred, and along with them, the colouring matters are destroyed by the acid. It is essential for the success of the process that the oil and the acid be not long in contact without undergoing dilution, otherwise the oil itself may become charred. It is, however, possible to obtain oil by this process in a fairly colourless condition, after it has been thoroughly washed with water, and allowed to settle.

3. Both rape oil and cotton oil may be rendered of a pale yellow, and even almost colourless, by a process of partial saponification with caustic alkali of a suitable strength. The colouring matters are saponified, and the resulting soap is of a dark yellow or brown colour, from the colouring matter having combined with the alkali.

4. By the action of chlorine produced in contact with the oil when, for instance, an aqueous solution of bleaching powder is acidified with a cheap mineral acid, such as dilute sulphuric. In this case rapid mixing and violent agitation are essential to the success of the process, otherwise chlorinised products are retained in the oil, which not only confer upon it a distinct flavour and odour, but also cause the oil to solidify with a very moderate lowering of the normal temperature. It is very questionable whether drying oils can, with advantage, be submitted to such treatment.

5. A variety of methods may be merely mentioned, such as treatment with sulphurous acid, with ferrous sulphate (green vitriol), and potassium dichromate and sulphuric acid. L. E. Andé's "Oel und Buchdrük Farben."

6. Lastly, there is the method of Binks, to which I shall have to refer further on.

On a New Process for the Preparation of Drying Oils of a Pale Colour.

Having thus far dealt in outline with the chemistry of drying oils, I propose to give a short account of certain improvements in the process of oil-boiling, which are founded upon a rational basis, and designed with the object of producing a drying oil absolutely free from lead, and, as compared with ordinary oils, absolutely free from colour.

The operations have been carried out, on a manufacturing scale, by Mr. W. E. B. Blenkinsop and myself, and there is no doubt, therefore, of the practicability of the process.

The process, as carried out by us, consists in, first, refining the oil, by the removal therefrom of water and mucilage; second, boiling and bleaching the oil at one operation.

It is a fact that water and mucilage can be removed from linseed oil by the action of certain dehydrating substances and solutions of metallic salts, as, for instance, by alum, by strong sulphuric acid—as in Thénard's process—and also as Wagner has proposed, by a solution of zinc chloride.

There are certain objections to each of these methods, which are of a practical nature: thus, in treating the oil with strong sulphuric acid, there is too frequently a charring of something, either the oil itself, or of some impurity therein, and this charring, though it may be very slight, has the effect of giving a slight brownish tinge to the oil, which cannot be completely removed by the bleaching process to which the natural colouring matters in the oil are amenable. It is quite true that this brown colour separates sometimes, but it is only after storage for a long period, when a finely divided flocculent matter separates by subsidence. Treatment with zinc chloride is satisfactory but expensive. Perfectly pure manganese sulphate, which is a neutral salt, has been used by us in very strong solution, and we should employ such a material where there is an objection to using an acid. For ordinary purposes we have found that perfectly satisfactory results are

obtained by the use of a dilute sulphuric acid, containing about 30 per cent. of $H_2 SO_4$, since, though it possesses the power of withdrawing water from the oil, it may, remain in contact therewith, without causing any charring, and at the same time it causes the precipitiation in a complete and rapid manner of all the mucilage. A purified linseed oil is thus produced which is bright, clear, and slightly yellowish in colour, though somewhat paler than the ordinary oil. It is important that the strength of the oil should not exceed that degree of concentration which is sufficient for the purpose for which it is intended. The oil having been so treated, and the impurities separated by subsidence or otherwise, it is next submitted to the bleaching and oxidising treatment. It is well known that C. Binks bleached oils and boiled linseed with oxides of manganese dissolved in the oil, but it is also apparent, from the specifications which he filed, that some difficulty was experienced in carefully regulating the quantity of the manganese compounds which were to be introduced into the oil. For instance, he precipitated manganous hydroxide in contact with oil, and added the mixture to the bulk of the material, and he also modified the treatment by dissolving manganous hydroxide in ammonia, and added the solution to the oil.

In our process we prepare manganese linoleate, and dissolve this in a hydrocarbon, and add a sufficient quantity of the solution to the oil, whereby it dissolves easily, and completely mixes therewith. By this treatment, the colouring matter of the oil forms a compound with the manganese which, while it remains in solution, is very speedily oxidised in contact with air, especially when a current of air of oxygen is blown through. The oxidation destroys the colouring matter, and the manganese compound is deoxidised, subsequently it undergoes oxidation again, and the products of such oxidation taking place in the oil are acrolein, formic and acetic acids. After, or concurrently with the oxidation of the colouring matters, the oil is oxidised, and, at a suitable temperature below 1·32°C., the oil is bleached, increased in density, and converted into a pale drying oil. By limiting the amount of the manganese linoleate to that which is capable of just oxidising the colouring matters, oils may be bleached with very little further oxidation.

Excellent drying oils have been produced by this process, of a very pale colour, samples of which are exhibited. The oil has been used for decorative house painting, for both indoor and outdoor work, on wood and on metal. It has also been used as a coating for iron work, without the addition of a pigment. The plant used in its production is the same as that employed in oil boiling by the usual processes, when a blast of air is used.

In order to show the advantage of using an oil of this description over that of ordinary boiled oil, it is necessary to point out the defects in usual makes of drying oils used by painters generally.

1. Zinc white, mixed with ordinary boiled oil, darkens.

2. Patent non-poisonous white lead, painted with ordinary boiled oil, darkens.

3. Paints made with lead sulphate and ordinary boiled oil, darken.

4. All delicate colours are darkened if mixed with ordinary boiled oil.

The advantages of a pale boiled oil, containing no lead, are the following:—

1. Zinc white retains its pure white colour.

2. Delicate tints, and colours containing sulphides, are not darkened in course of time.

It may be suggested that for indoor decoration, for the painting of ships, railway carriages, railway semaphores, signs, and stations, such oil is free from liability to alter the colours with which it is mixed owing to its freedom from lead, which is darkened by traces of sulphuretted hydrogen in the air, to which such paints are exposed.

Gasometers in gas-works may be painted an unalterable white with such oil and zinc white. But in this case also the zinc white must be free from lead carbonate or oxide.

The following specimens were exhibited to illustrate the description of Messrs. Hartley and Blenkinsop's process for bleaching oils and preparing pale boiled oils:—

(1.) Six samples of ordinary brown boiled oil from different makers.

(2.) Five samples of pale boiled oil from different sources.

(3.) A sample of raw linseed oil, showing natural colouring matters.

(4.) The same, purified from mucilage. (H. and B.'s process.)

(5.) The same, bleached.

(6.) The same, converted into boiled oil.

(7.) Samples of bleached linseed, poppy, and cotton-seed oil.

Various lead and manganese compounds used as dryers were shown.

Experiments were made, which showed the effect of the lead in ordinary boiled oil, and in pale boiled

oil on delicate colours, and on zinc white, when exposed to impure air.

Panels painted with zinc white and pale boiled oil, prepared by the new process, were shown to be not only of purer colour, but quite unaffected by sulphuretted hydrogen.

DISCUSSION.

The CHAIRMAN said this was an extremely interesting and valuable paper. It seemed to him that practically the material covered by it might be divided into two parts; first the scientific examination of these oils and their constituents, and the changes they underwent; and secondly, the practical outcome of such an investigation. At the outset, in connection with the first, second, and third points mentioned in relation to Chevreul's work, there arose the question of the action of lead and zinc compounds on drying oils, and they saw at once that both these substances, as distinguished from antimony, arsenic, and tin, were metals which formed basic compounds, and thus assisted in giving oxygen to the oils. The next point was the interest arising from the systematic manner in which Professor Hartley had arranged his own work and experiments. Then came the question with regard to the manganese compounds, and there it was found that the quantity of manganese should not exceed a certain proportion, excess giving a bad result. One of the great points of importance to himself, looking at it rather from the scientific than the practical point of view, was the investigation into the constitution of these oils. It appeared that the acids in them were what chemists called "of an unsaturated nature," and not only unsaturated compounds, but also those which had a great tendency to form hydroxy compounds. This was a most important point in regard to the action of oxygen on the drying oils. As had been stated, the term "drying" was not quite correct, and he should certainly prefer to use the word hardening. If they would look at the actual constituents of these oils, as given in the table of the oils generally used with pigments, it would be seen that ricinoleic, linolic, linolëic, and linolenic acids were constituents of all the oils which were used as drying or hardening substances; they were all bodies which formed hydroxy compounds. There were many other points of interest in connection with the action of the metals on the drying of oils, and, finally, there was the practical application of the knowledge which had been obtained through Professor Hartley's investigations, on which he had no doubt there were some present who would be prepared to speak with more authority than he could.

Professor ROBERTS-AUSTEN, F.R.S., said he had listened to the paper with great interest, but he knew but very little of organic chemistry. In fact, the frightful consequences which resulted from a slight displacement of the position of a carbon atom in the molecule of an organic substance, had deterred him from paying as much attention to this branch of chemistry as he ought. But he had been greatly interested in the relations between the organic and mineral substances of which Professor Hartley had spoken. There was only one point of an antiquarian character on which he thought he might make a remark. It was not Van Eyck, but Otto Tachen who anticipated Chevreul in pointing out the saponifying action of litharge (1666).

Mr. LAURIE said he had never used linoleate of manganese for boiling with oil, but by the use of borate you did get a boiled oil, which was certainly paler than the oil with which you started. If you took linseed oil which had been already bleached in the sun a golden yellow, and converted it into boiled oil with manganese, a further bleaching process undoubtedly took place. An oil prepared with manganese salts, spread on a glass plate, and allowed to dry in the dark, would remain almost colourless, whereas if it were boiled with a lead salt it quickly darkened, even if it were kept away from impure air. Even in a dark room, in pure air, a picture painted with oil boiled with lead would darken. That was another argument in favour of manganese, and he should say it ought always to be used in preparing oil for artistic purposes. He did not quite gather how Prof. Hartley used the manganese, and what advantage he claimed for the linoleate over the borate. He would also ask if he found the oil dry as quickly as when prepared with lead; in his experience it did not, so that for rough purposes, where quick drying was important, and the colour did not much matter, he should think oil prepared with a lead salt would be preferable. He could not agree that zinc sulphide might be regarded as a permanent pigment, for his experience was that it was very treacherous. Zinc oxide was permanent, but not sulphide. The paper was a very valuable contribution on an obscure and troublesome subject.

Mr. WALTER REID said Mr. Hartley had gone so fully into the subject that there was little more to be said from a theoretical point of view. The account of recent researches on linolëic acids was very interesting. Sativic acid, which seemed to be the end product of the oxidation of linolëic acid, was, no doubt, formed when the oxidised linseed oil was exposed to air. It was a substance which existed in all old oil paintings, in those round the walls it was not linolëic acid which was now present, but the subsequent oxidation product. He believed that sativic acid was produced by oxidising linolëic acid with permanganate of potash, and no doubt the action of that salt would be very different to the slight oxidation which took place on exposure to the air. There was no doubt, also, that when this hard or elastic substance, linolëic acid was exposed to the air for a number of years, it became soft and viscid. On the occasion of Professor Laurie's paper, he showed some

of the oxidised oil which had become somewhat liquid and viscid, simply by further exposure to the atmosphere. One question he should like to ask with regard to saponification by dryers, the quantity of dryers used in boiling oil was extremely small, and, practically, when you allowed for the oxygen of the lead salt, it did not amount to 1 per cent. of the whole mass, so that the saponification could have very little influence on the oil. It must be either as a carrier of oxygen, or in some other way that the dryers acted, and on this point there was this to be said, if you boiled linseed oil with dryers, and excluded the air, the oil would dry very much better than if it had not been boiled at all with dryers; consequently there must be some interaction between the dryers and the constituents of the oil which caused the oil to dry subsequently. This was a point of some practical importance, because oil was frequently boiled under circumstances where the air had not free access to it; there were hoods put over it, which became full of fumes, and contained very little oxygen indeed. He heard no reference made to the process of Andè, only the use of borate of manganese and linoleate of manganese. By his process, sulphate of manganese was treated with caustic potash, and the liquid then added to linseed oil, and heated to about 70° or 80° C.; and then the air was blown through it for four or five hours. That came into use in Germany, and was still employed there. Von Pettenkoffer, in a work published at Munich some years ago, referred to the extensive use of linoleate of manganese as a dryer. It was dissolved in turpentine; and he said its best known name was "siccative de Courtray." He must congratulate Mr. Hartley very much on his elimination of lead. Everyone knew what an injurious substance lead was, how easily it got into the system, and how difficult it was was to get it out. Painters' colic was a disease which filled many beds in the hospitals, and filled them for a long time; and if Mr. Hartley could get rid of the use of lead in paint, he would have done a great and lasting service.

Professor HARTLEY was aware that various solutions of oleates and linoleates are used on the Continent, the preparation of which is kept secret, but their use is that of dryers for refined linseed oil or pigments mixed therewith. Mention is made of these substances in the *Oil and Colourman's Journal*, and in L. E. Andé's recently published work.

Mr. VAUGHAN said, as a matter of history, he recollected the salts of manganese being introduced by Christopher Vince about 1848. With regard to the saponification of oil by lead salts, he thought the action of litharge on glycerine might be noted as the basis of the alteration by treatment with lead.

Mr. N. CLARKE asked whether Professor Hartley subjected his oil to any great heat, such as 600°, and whether it darkened in colour under heat. A fatal objection to manganese in any form for the manufacture of varnish was, that the oil bloomed, and produced a bloom on any varnish made with it. He should think that would also be an objection to its use for painting.

Professor HARTLEY said he had not found that as he used it.

Mr. WOLLASTON asked if Professor Hartley was aware that manganese linoleate had been made the subject of a patent.

Mr. ROBERTS said he had found that crude oil which contained mucilage could be bleached, by simply blowing air through it at a temperature of about 200°.

Professor HARTLEY, in reply to Mr. Laurie's first question, said that one of the advantages of using linoleate of manganese was first that it acts as a bleaching agent and afterwards as a dryer, and no foreign substance is introduced into the oil which is not active in this respect. It is also more efficient than other salt. With respect to the question whether oils treated with lead did not dry more quickly than those treated with manganese, he said he had tried it experimentally, and by proper treatment, with a suitable quantity of manganese, he had always found that the manganese oils dried as quickly as the others. He also noticed that the film produced by a manganese oil, even if it were slow drying, was exceedingly tough, superior, in that respect, to what one got from some lead oils; in fact, with the latter, the film sometimes became rather brittle. With regard to the oxidation of linoleic acid, and the production of an elastic substance, the question of what that elastic substance was, was one of very great importance, and, to him, of very great nterest. A remark was made as to the interaction of the dryers and the oil to form a substance which subsequently hardened. There was no doubt that was the case. The action of lead dryers appeared to him to consist in the formation of a lead salt which underwent a change; it was continually being decomposed and reformed by the action of the air, but what the precise change was he was not at liberty to say. When you were dealing with the constitution of linoleic acid a number of reactions could be imagined, but they had yet to be tested by experiment, and it was this very point which made the subject so intensely interesting to him. He was quite aware that linoleate of manganese had been made the subject of a patent, because Mr. Blenkinsop and he had a patent for the use of it. It was previously patented in the United States as a distinct substance, that is to say, the preparation of the material was patented, but that did not prevent Mr. Blenkinsop and himself from obtaining a patent in the same country for bleaching oils and producing pale drying oils by the use of it. Professor Hartley expressed himself as

much indebted to Mr. Blenkinsop, managing director of the firm of May and Baker, Limited, for taking the trouble to provide the specimens exhibited.

The CHAIRMAN then proposed a vote of thanks to Prof. Hartley for his exceedingly valuable and suggestive paper, which was carried unanimously.

APPLIED ART SECTION.

Tuesday, February 7, 1893; Sir HENRY DOULTON, Vice-President of the Society, in the chair. The paper read was on "Pottery Glazes: their Classification and Decorative Value in Ceramic Design," by WILTON P. RIX.

The paper and discussion will be printed in the next number of the *Journal*.

Miscellaneous.

THE FISHERIES OF TONQUIN.

The French representative in Tonquin, in a report recently addressed to his Government, says that fish are found in very considerable quantities on the coasts of Tonquin, and on those of the province of Vinh and Than-hoa. The fish, when taken, which is chiefly by fishermen in Chinese junks, is transhipped on other junks, and quickly forwarded to Pack-hoï, whence it is sent into the interior. The fishing season commences about the end of September or the beginning of October—the last months of the hot season. As this period, junks from China, and particularly from Pack-hoï, arrive in flotillas of from 50 or 60, at the port of Cac-bâ, where they are fitted out and put in order for fishing. After some days employed in this manner, the fleet sets out. Each junk is manned by from seven to ten persons, of whom some are women and children. The fish taken in the waters of Tonquin are chiefly composed of the following varieties:—*Vang tiack*, a white fish, weighing about 25 kilogrammes, and much appreciated; *tai-teï*, a species of gold fish, average weight 8 to 10 kilogrammes; *xi-pha-gui* and *ougui*; the *sa-hi*; the *stiong-loû*, which very closely resembles the sardine; the *mangui*, and the *sha-hi*. The other varieties are generally employed in the fabrication of *nam*, a kind of pickle; and these comprise the *ta-hou-lou*, or carp, the *long-ly*, or sole, and the *moung-sin*. According to the situation of the sandbanks, against which the fish gather in shoals, fishing is carried on by means of a large net, sometimes extending in length to as much as 500 yards, and having in the middle a vast receptacle or pocket composed of strong and closely-drawn meshes. Two junks start off with the net, one taking each end, and they drag it over a distance of several miles. A man in a rowing boat follows, and from time to time dives to see if any fish has been taken into the pocket of the net. When a haul is made, the two junks come together and take in the net, from which the fish are removed by means of baskets. It frequently happens that the take consists of several thousand kilogrammes of fish. When the weather and the situation of the banks does not permit of this method of fishing, each junk makes use of an ordinary drag-net. There are very few lobsters in Tonquin, but oysters abound, and the rocks of the archipelago are covered with them, and although the oysters themselves are of small dimensions, they are of excellent quality. Europeans, alone, are in the habit of eating this mollusc, and it is only obtained for them. The Annamites cook the oysters and eat them only when everything else fails. There are some descriptions which are dangerous to health, and create in the person partaking of them symptoms akin to those of poisoning No oyster beds have yet been laid down. In the bay of Van-haï there were, during the course of the last century, pearl oysters, in the fishing of which the Chinese were largely engaged, and this industry, for a period of about twenty years, was said to be a most lucrative one. The quantity of products yielded by the waters of the littoral is immense. Without taking into consideration the thousands of individuals who live by this industry, the transport of fish — fresh, dried, salted, or preserved — into the interior of the country, assumes each year very large proportions. According to the statistical returns, the annual quantity of fish taken and consumed in Tonquin is estimated at 30,000,000 kilogrammes.

Obituary.

ALFRED CARPMAEL.—The Society of Arts has sustained a severe loss by the death, on the 1st inst., of Mr. Alfred Carpmael, a member of the Council and of the Royal Commission for the Chicago Exhibition. In both these positions Mr. Carpmael placed his wide and special knowledge and experience at the service of his colleagues for the advancement of the objects they all had in view; and as legal adviser to the Council, his services were of the greatest value. Mr. Carpmael, who was the second son of the late Mr. William Carpmael, M.Inst.C.E., the most prominent patent agent of his time, was born on the 9th February, 1835. He was educated at the Clapham Grammar School, under the Rev. Charles Pritchard, F.R.S., now Savilian Professor of Astronomy at Oxford, and was admitted a solicitor in the year 1857. A few years later he became a partner in the firm of Wilson, Bristow, and Carpmael, of which he remained a member to the time of his death. This firm acted as solicitors to the original

Electric Telegraph Company, and remained so until this company's business was taken over by the Government. They are still honorary solicitors to the Institution of Electrical Engineers and to the Chemical Society. They acted in the same capacity for the British Section of the Exposition Universelle of Paris in 1889, and now act for the Royal Commission for the Chicago Exhibition of 1893. From 1882 to 1891 Mr. Carpmael was a member of the Council and a Vice-President of the Society of Arts. In 1891, he retired by seniority, in accordance with the Society's bye-laws, but was elected again in 1892, and thereby became a member of the Royal Commission for the British Section of the Chicago Exhibition. He was present last October at the Dedicatory Ceremonies at Chicago, as a representative of the Royal Commission, and he presented a report, which was printed in the *Journal* for November 18, 1892 (see *ante* p. 19). Mr. Carpmael, in conjunction with his brother, Mr. Edward Carpmael, the well-known barrister, published "The Patent-laws of the World," which is the standard work of reference on this subject. Mr. Carpmael was one of the chief authorities on Patent-law, and he took a prominent part in the work which has been done by the Society of Arts of late years in respect to this subject. He took a great interest in the scientific questions of the day, was a life member of the British Association, and also one of the Board of Visitors of the Royal Institution. He was an Associate of the Institution of Civil Engineers and of the Chartered Institute of Patent Agents. Mr. Carpmael was a frequent attendant at the evening meetings of the Society of Arts, and his genial presence will long be missed by a large circle of friends.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

FEBRUARY 15.—PROF. FRANK CLOWES, D.Sc., "The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air." SIR FREDERICK ABEL, K.C.B., F.R.S., will preside.

Papers for subsequent meetings, the dates of which are not yet fixed:—

"Transatlantic Steamships." By PROF. FRANCIS ELGAR, LL.D.

"Tele-photography." By THOMAS R. DALLMEYER.

"The Optical Correction of Photographic Perspective." By H. VAN DER WEYDE.

"Old Age Pensions." By T. MACKAY.

"Music in Elementary Schools." By W. G. MCNAUGHT.

"Technical Education: its Progress and Prospects." By Sir PHILIP MAGNUS.

"Locks and Keys, Ancient and Modern." By HARRY W. CHUBB.

INDIAN SECTION.

Thursday afternoons:—

FEBRUARY 16.—Sir WILLIAM WILSON HUNTER, K.C.S.I., C.I.E., LL D., "The Progress of India under the Crown." The MARQUIS OF RIPON, K.G., G.C.S.I., C.I.E., will preside.

*** This meeting will take place at 3 p.m. instead of 4·30 p m.

MARCH 9.—JERVOISE ATHELSTANE BAINES, I.C.S. (Bombay), "Caste and Occupation at the last Census of India." The LORD REAY, G.C.S.I., G.C.I.E., will preside.

APRIL 6.—The Hon. Sir EDWARD N. COVENTRY BRADDON, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisation."

APRIL 27.—Sir JULAND DANVERS, K.C.S.I., "Indian Manufactures." Sir ALEXANDER WILSON, formerly President of the Bengal Chamber of Commerce, will preside.

MAY 11.—Sir RAYMOND WEST, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results."

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock:—

FEBRUARY 28. — SIR EDWARD BRADDON, K.C.M.G., "Russia as a Field for Tourists." Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., will preside.

MARCH 21.—CECIL FANE, "Newfoundland." Sir CHARLES TUPPER, Bart., G.C.M.G., will preside.

APRIL 18.—H. A. MCPHERSON, "The Philippine Islands."

MAY 2.—E. DELMAR MORGAN, "Russian Industrial Art."

MAY 18.—W. B. PERCIVAL, Agent-General for New Zealand, "New Zealand."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

FEBRUARY 21.—T. R. SPENCE, "Wall-papers and Stencilling." LEWIS F. DAY will preside.

APRIL 11.—PROF. PAUL SCHULZE, "History and Development of Pattern Designing in Textiles." THOMAS WARDLE will preside.

MAY 9.—W. M. FLINDERS PETRIE, "Primitive Art in Egypt." EDWARD J. POYNTER, R.A., will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

PROF. J. A. FLEMING, M.A., D.Sc., F.R.S., "The Practical Measurement of Alternating Electric Currents." Four Lectures.

LECTURE III.—FEBRUARY 13.—*The Measurement of Alternating Current Power.*—Apparent and real power—Power factor of a circuit—Power-meters or wattmeters — Electrostatic and electrodynamic

forms of wattmeter — Wattmeters for inductive circuits — Wattmeters employed on high tension circuits—Methods of testing efficiency of alternators and transformers—Methods of regulating pressure on testing circuits.

HOWARD LECTURES.

Friday Evenings, at Eight o'clock:—

PROF. W. CAWTHORNE UNWIN, F.R.S., "The Development and Transmission of Power from Central Stations."

LECTURE VI.—FEBRUARY 17.—Distribution of mechanical energy by electricity—Systems hitherto adopted—Examples of distribution of motive power electrically—Hersthal installation—Niagara scheme—Advantages of combined schemes — Heat and power—Light and power—Water supply, light, and power.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 13 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. J. A. Fleming, "The Practical Measurement of Alternating Electric Currents." (Lecture III.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Report by the Committee on Dr. Stevenson Macadam's Paper, on "Explosions in Flour Mills, &c." 2. Mr. William Bennett, on "The British Navy: Past and Present." 3. Dr. W. G. Black, "Meteorology at the Seaside, English Channel (Winter)." With Diagrams and Instruments.

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Colonel Lenox Prendergast, "The Cathedral of Palma, Majorca; its Origin and Development, with some Notes of Minor Buildings in its Neighbourhood."

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Shelford Bidwell, "Electricity and Heat."

TUESDAY, FEB. 14...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "On the Functions of the Cerebellum and the Elementary Principles of Psycho-Physiology."

Asiatic, 22, Albemarle-street, W., 4 p.m.

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-st., S.W., 8 p.m. Dr. Edward Hopkinson, "Electrical Railways."

Sanitary Institute, Parkes' Museum, Margaret-street, W., 8 p.m. Prof. H. Robinson, "Sewerage and Sewage Disposal."

Photographic, 50, Great Russell-street, W.C., 8 p.m. Annual Meeting.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Prof. T. Jeffrey Parker, "The Cranial Osteology, Classification and Phylogeny of the *Dinornithidæ*" 2. Mr. R. Lydekker, "The presence of a distinct Coracoidal Element in Adult Sloths, with remarks on its Homology.' 3. Dr. G. Radde, "The present Range of the European Bison in the Caucasus." 4. Dr. C. J. Forsyth-Major, "Some Miocene Squirrels, with remarks on the Dentition and Classification of the *Sciurinæ* in general."

Colonial Inst., Whitehall-rooms, Hotel Metropol[e], S.W., 8 p.m. Prof. Robert Wallace, "Australasia[n] Agriculture."

WEDNESDAY, FEB. 15...SOCIETY OF ARTS, John-stree[t], Adelphi, W.C., 8 p.m. Prof. Frank Clowes, "Th[e] Detection and Estimation of Small Proportions o[f] Inflammable Gas or Vapour in Air."

Meteorological, 25, Great George-street, S.W[.], 7 p.m. 1. Mr. Edward Mawley, "Report on th[e] Phenological Observations for 1892." 2. M[r.] William Ellis, "Relation between the duration o[f] Sunshine, the amount of Cloud, and the height o[f] the Barometer." 3. Mr. W. Piffe Brown, "Wint[er] Temperatures on Mountain Summits."

Microscopical, 20, Hanover-square, W., 8 p.m[.] 1. Mr. E. M. Nelson, "The Chromatic Curves o[f] Microscope Objectives and an Improved Form o[f] Edinger's Apparatus for Drawing Objects Unde[r] Low Powers." 2. Surgeon V. Gunsen Thorpe[,] "The Rotifera of China." 3. Dr. G. M. Giles[,] "Certain Cystic Worms which Simulate the Ap[-]pearance of Tuberculosis."

Archæological Association, 32, Sackville-street, W[.], 8 p.m.

Inventors' Institute, 27, Chancery-lane, W.C., [8] p.m.

United Service Institute, Whitehall-yard, 3 p.m[.] Captain W. C. Crutchley, "The Probable Effec[t] of the Changes in Modern Warfare on the Mer[-]cantile Marine."

THURSDAY, FEB. 16 ... SOCIETY OF ARTS, John-street[,] Adelphi, W.C., 3 p m. (Indian Section.) Si[r] William Wilson Hunter, K.C.S.I., C.I.E., LL.D. "The Progress of India under the Crown."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr[.] Charles Plowright, "The Life History of the Æcidium on Paris quadrifolia." 2. Mr. J. C[.] Willis, "Contributions to the Natural History of the Flower."

Chemical, Burlington-house, W., 8 p.m. 1. Mr[.] W. A. Shenstone, "Platinous Chloride." 2. Dr[.] Kipping, "Melting Points of Compounds of Similar Constitution." 3. Dr. Walker, "Electrolysis of Sodic Ethylic Compounds." 4. Dr. Dobbie and Mr. A. Lander, "New Base from Corydalis Cara."

London Institution, Finsbury-circus, E.C., 6 p.m[.] Prof. Rhys Davids, "The Women in the Buddhists' Reformation of the 6th Century B.C."

Royal Institution, Albemarle-street, W., 3 p.m[.] Prof. Patrick Geddes, "The Factors of Organic Evolution."

Historical, 11, Chandos-street, W., 8½ p.m.

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, FEB. 17 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lectures.) Prof[.] Cawthorne Unwin, "The Development and Transmission of Power from Central Stations." (Lecture VI.)

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. A. H. Church, "Turacin, a remarkable Animal Pigment containing Copper."

Sanitary Institute, Parkes' Museum, Margaret-street, W., 8 p.m. Mr. H. H. Collins, "Sanitary Building Construction."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m. Annual Meeting.

Geological, Burlington-house, W., 3 p.m. Annual Meeting.

SATURDAY, FEB 18...Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Sound and Vibration."

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FRIDAY, FEBRUARY 17, 1893.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

Prof. J. A. Fleming, M.A., D.Sc., F.R.S., elivered the third lecture of his course on The Practical Measurement of Alternating :lectric Currents" on Monday evening, 13th ıst.

The lectures will be printed in the *Journal* uring the summer recess.

HOWARD LECTURES.

Prof. W. Cawthorne Unwin, F.R.S., elivered the fifth lecture of his course on The Development and Transmission of ower from Central Stations," on Friday ening, 10th inst.

The lectures will be printed in the *Journal* uring the summer recess.

Chicago Exhibition, 1893.

'ORLD'S CONGRESS AUXILIARY.

The following circular letter has been re-:ived by the Royal Commission from the merican Minister through the Foreign-fice :—

Department of State,
Washington, January 5, 1893.

'o the Diplomatic and Consular Officers of the United States.

Gentlemen,—Referring to the Department's cir-lar of the 13th of June last, relative to the World's ngress Auxiliary to the Columbian Exposition, l in furtherance of the request received in a letter ed the 15th instant from Mr. Charles C. Bonney, :sident of the World's Congress Auxiliary, the lowing facts are communicated to you for your ɔrmation, and such communication to the Govern-nt to which you are accredited as circumstances y require.

It is especially desired that the delegates from the different countries to the World's Congresses of 1893 be of such a number as to fairly represent the progress and condition of the various departments of enlightened life. Where the number of persons eminent in the department of a given congress is large, a delegation sufficiently large to be fairly representative of the whole is cordially invited ; and in cases where the number of such persons is relatively small, a corresponding decreased delegation will be heartily welcomed. Five, or ten, or twenty, or a larger number of delegates might thus be an appropriate number, according to the circumstances of the particular case.

Among those persons whose appointment, attendance, and participation are especially solicited, the following may be mentioned :—

For the congresses of the Department of the Public Press, eminent representatives of the daily press, religious journalism, reviews and magazines, and important scientific and professional publications, to consider the office, duties, and responsibilities of modern journalism, with especial reference to its international relations and influences.

For the congresses of the Depaartment of Public Health and Medicine, those best qualified to deal with the questions of health and sanitation, especially with such as concern the prevention and control of epidemics and contagions, and the applications of modern medical science to the promotion of the general comfort and welfare of the people.

For the congresses of the Department of Temperance, those whose position and experience entitle them to be heard in regard to the best and most practicable methods of decreasing or preventing the world-wide evils wrought by the abuse of intoxicating drinks.

For the congresses of the Department of Moral and Social Reform, the leaders of the various modern movements for the amelioration of moral and social conditions, particularly in the Department of Charity, Correction, and Philanthropy ; the treatment of pauperism, insanity, and crime and kindred subjects.

For the congresses of the Departments of Commerce and Finance, eminent bankers and financiers, officers of commercial exchanges, representatives of railway commerce, leaders in water commerce, officers of building associations and like organisations, eminent merchants, and representatives of the various branches of insurance.

For the congresses of the Department of Music, including orchestral, choral, popular, and church music and musical literature, criticism, and history, musical composers, performers, and educators.

For the congresses of the Department of Literature, historians, librarians, philologists, literary archæologists, students of folklore, poets, novelists, and other authors and copyright representatives.

For the congresses of the Department of Education, members of the faculties of colleges, univer-

sities, and other high institutions of learning, public school authorities and eminent teachers, heads of business and commercial colleges, leaders in physical culture, prominent educators of the deaf and the blind, and other educational representatives.

For the congresses of the Department of Engineering, leading representatives of civil engineering, mechanical engineering, mining engineering, metallurgic engineering, electrical engineering, marine and naval engineering, aërial navigation, and engineering education.

For the congresses of the Department of Art, architects, painters, sculptors, decorative artists, photographic artists, and directors of art museums and schools.

For the congresses of the Department of Government, lawyers, judges, and statesmen; leaders in political economy, social science, economics, and statistics; taxation and revenues, profit-sharing, and kindred subjects; also persons especially qualified to consider the international relations of weights, measures, coinage, and postage; the nature and relations of suffrage in republic, kingdom, and empire; the condition and improvement of the government of cities; the nature and relations of executive administration in republic, kingdom, and empire; the nature and protection of intellectual property, including patents and trade-marks; also representatives of movements for the establishment of courts of conciliation, tribunals of arbitration, and the general substitution of some form of judicial decision for the wager of battle for the settlement of international controversies.

For the congresses of the Department of Science and Philosophy, eminent philosophers and scientists of all classes.

For the congress on African Ethnology, including the continent, its people, and future, it is desired that the most eminent representatives who can be named will be selected, in view of the very great importance of the questions involved in the present movement for the civilisation of the "Dark Continent."

For the congresses of the Department of Labour, eminent representatives of the movements which have thus far proved reasonably successful in increasing the compensation and improving the condition of the toiling masses.

For the congresses of the Department of Religion, eminent representatives of the various forms of religious faith which prevail in the different countries. These congresses will embrace a fourfold programme for the presentation in separate sessions of grounds of union or sympathy on the one hand and distinguishing characteristics on the other, with informal conferences for those who may desire further information, and independent denominational conventions for their own proper work. In this connection will be held congresses of missionary societies and the semi-religious organisations.

For the congresses of the Department of Sunday Rest, representatives of the physiological, the eco nomical, the governmental and political, the soci and moral, and the religious aspects and relation of the weekly rest day.

For the congresses of the Department of Agr culture, public officers having agricultural interests i charge and other leading representatives of agr cultural interests, including farm culture, anim industry, agricultural organisations, agricultural edu cation and science, household economics, and kindre subjects.

The specific work of all these congresses will be t sum up human progress in the respective departmen to the year 1893, to make clear statements of th living problems which still await solution, and t suggest in brief and explicit form the means by whic further progress may be made. A chief object of a these congresses is to collect and furnish, for the us of the Governments and peoples of all the partic pating countries, information and views which will b useful as means of further progress. The dates o which the respective congresses will commence the sessions are given in the accompanying general pro gramme.

It is especially desired that, as far as may be con venient, the delegates from each country be appointe to attend the entire series of the World's Congresse to be held from May to October, 1893. Should it b convenient for the appointing Governments to compl with this desire, and to send their delegates t America early in the Exposition season, it is believe that the general participation in all the congress which would thus be secured, would greatly increas the benefits which are expected to result from th proceedings for which arrangements have been mad

It is also deemed advisable that information b given to the Government to which you are accredite that the proceedings of the several congresses o 1893 will not be approved or disapproved by vote o the persons who may be in attendance, but that suc proceedings will be submitted to the future delibera judgment of the enlightened world, to be expresse in what the Government and people of each countr may, after mature consideration, deem appropria and desirable action, whether official or otherwise.

It is further requested that the proper officers o the Government to which you are accredited b informed that, as far as may be practicable, th programmes for the several congresses will be kep open for the appointment of such delegates, in orde that they may be specially invited to participate by the presentation of appropriate papers, in th proceedings. Such participation will be regarded a without any possible prejudice to the appointin Government; and if in any particular case th Government shall prefer to have its delegates tak no active part in the proceedings, but merely t attend and witness them, that desire will be scrupu lously respected.

A suitable number of the general programme o the congresses to be held under the auspices o

he World's Congress Auxiliary will be sent to you, nd you will distribute the same in the manner best alculated to promote the end in view. This general nogramme contains, among other things, an explanaion of the organisation, departments, and general livisions in which the congresses are to be held, the rder and dates of the various congresses, and other tems of explanatory matter.

As the intervening time is brief, and the need of efinite arrangements for particular papers, by selected ersons, for the various congresses is urgent, it is arnestly hoped that the several diplomatic and conular officers of the United States will supplement he foregoing information with such personal explanaions and efforts as the occasion may seem to equire.

I am, Gentlemen,

Your obedient servant,

JOHN W. FOSTER.

Copies of the General Programme of the Congresses can be obtained on application to he Secretary, Society of Arts, John-street, Adelphi.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, February 7, 1893; Sir HENRY DOULTON, Vice-President oof the Society, in he chair.

The paper read was—

ON POTTERY GLAZES: THEIR CLASSIFICATION AND DECORATIVE VALUE IN CERAMIC DESIGN.

By WILTON P. RIX.

In approaching the subject which I have entured to bring before you, I am well aware hat others have previously dealt—far more bly than I could hope to do—with many of ne details which may now occupy our atten-on. Nevertheless, it seemed possible to dd some points of interest to the valuable ectures already delivered before the Society notably those of Professor Church, on "Pottery nd Porcelain"), by entering somewhat more losely into the range of practical ceramics.

While attempting to draw some distinctions etween various glazes, I propose to show how nportant a part is played by the composition nd quality of these in enhancing the beauty f ceramic decoration; also touching briefly n some of the complex optical principles in-olved in the due appreciation of its merits.

In many cases glaze is to a pottery designer what the canvas is to a picture painter—the field whereon he is able to express his conceptions. But it is sometimes more than this; it is often the varnish which, while protecting his work, gives brilliancy to his colouring. Nor is this all: in many instances it is allowed to become the vehicle by means of which the design is harmonised, and mellowed into a beauty of tone, only possible to the painter on canvas after long years of patient waiting for time itself to effect.

Glaze may be translucent, transparent, or refractive; it may be iridescent, or full of the richest colouring; and it may be soft as vellum, or brilliant as the diamond in its texture; in short, it is capable of producing, under the touch of a master hand, a harmony of result, rich and powerful in tone as an autumn sunset, or tender and delicate as the dawn of spring.

It is not necessary to occupy time by referring to the origin and development of glaze in pottery. The various stages, from the closing of the surface of a porous, sunbaked ware, with some cerate to make it water tight, onward to the brilliant texture of true porcelain, embrace the entire range from primitive utility to the highest decorative embellishment, fascinating to the eye and exquisite to the touch.

Though the functions of a glaze are mainly to render the ware impervious and cleanly, and to impart smoothness to the surface, it must be conceded that, in decorative pottery, these qualities are often made to subserve the embellishment of the object.

In the case of this Satsuma vase, for instance, the fine crackle adds greatly to the beauty of the result; but it undoubtedly holds the dirt and grease.

It is no part of our province, at present, to discuss how far such sacrifice of the useful to the æsthetic is legitimate. It will rather be attempted to show how the treatment of the glaze itself may serve to enhance the beauty of the material, by employing its peculiarities to the best advantage in the decoration of the ware.

DEFINITIONS.

Two main sub-divisions are at once marked out by the method of the preparation, viz., *raw and fritted glazes.*

A glaze may have all the materials requisite to its composition carefully ground, and held

in suspension by water or other vehicle, and when the needful heat is applied upon the surface of the ware, these materials are fused into a vitreous glaze or enamel—as shown in these specimens of fired and unfired enamelled stoneware—such is termed a "raw" glaze.

It is possible to secure satisfactory fusion by this method when the materials are insoluble, but when soluble alkaline and other salts are added, it is necessary to melt, or flux, the ingredients together, thus insuring ultimate vitrefaction. After grinding the resulting "frit" in water, the ware is, as before, covered with this "fritted" glaze, as shown in this example of earthenware.

Moreover, the composition may be so arranged that the firing of the ware and of the glaze is accomplished at one operation, or, if necessary, the body may be fired before glazing.

For decorative purposes, these distinctions have a most important influence on the result, as will hereafter be seen.

The general term, glaze, may be broadly divided, according to texture, into five main divisions :—

1, Enamels; 2, Glazes; 3, Smears; 4, Flows; 5, Salt or Vaprous Glazes; 6, Lustres.

1. *Enamels* may be opaque or translucent. Covering the surface they altogether conceal or partially modify the colour of the ware beneath. This may be effected by various means :—

(*a*) By fusion with metallic oxides, as tin or arsenic.

(*b*) By suspension of opaque particles in a transparent glaze.

(*c*) By semifusion of raw glaze.

Examples of each of these methods are here seen.

2. *Glazes*.—The term glaze is properly confined to a transparent varnish covering the ware. It may be :—

(*a*) Colourless.
(*b*) Stained, or
(*c*) Curdled.

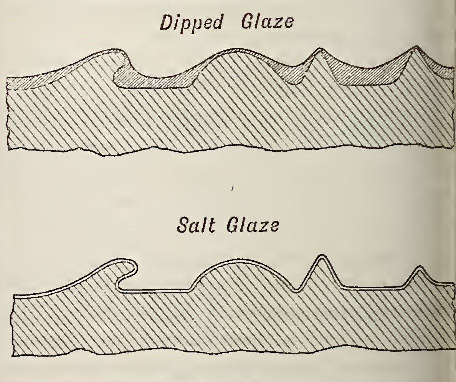
(Specimens of each are shown on the table.)

3. *Smear* is a thin, transparent semiglaze sublimed on the ware during firing. The inner surface of the sagger in which the object is placed in the kiln is washed with a mixture of lead, alkali, or other material capable of volatilising by high temperature. Small quantities of this mixture are sublimed upon the ware, giving the delicate texture seen here. When a clay contains much soluble alkaline salt, these by evaporation of moisture are brought to th surface, and during firing often produce "smear" upon the ware.

4. *Flows* are somewhat distinct fro "smears," although applied similarly. Volati salts are mixed with carbonate of lime, &c and placed within the sagger, causing a vapou which increases the fusion of the glaze alreac laid upon the ware, at the same time swin ming the colour, and thus imparting softness t the design as shown here.

5. *Salt Glaze*.—Altogether distinct from th above methods is that of salt glazing—mad familiar to most by the interesting examples old Grès de Flandres and Burslem stonewar and in modern times by the well-known pr ductions of Messrs. Doulton, at Lambet The process so often described is as simple its operation as it is complex in its chemic reaction. The ware, when dry, is placed with out glazing in the kiln. When at the vitrifyin temperature common salt is added throug small holes in the roof of the kiln. The cons quent vapour fills the entire interior of the kil attacking every portion of the surface of th ware, and forms by chemical combination a extremely hard and thin glaze. One grea advantage of this method is the equality o thickness afforded by the glaze to every pa exposed. In a dipped glaze, on the contrar the hollows are often unduly filled up to th detriment of the piece, as seen in th diagram.

Fig. 1.



Sections shewing Comparison of Dipped an Salt Glaze.

6. *Lustres* are sometimes produced by th decomposition of a metallic glaze on its sur face through the exposure to reducing atmo sphere in the kiln. The best results are ver difficult to attain.

Classification.

The classification of glazes has been attempted at different times with varying success. Brongniart gives three classes only:—

1. Varnish, or glazes fired at low heat, including those with lead and borax.

2. Enamels, or opaque glazes.

3. Cover, or glass-earth, including those which mostly fire at high temperatures equal to that of the ware itself.

Salvetat divides into seven classes, thus:—

1. Lead glaze—Coarse earthenware.

2. Boracic glaze—Granite ware, fine earthenware.

3. Tin glaze—Urbino ware. Della Robbia ware.

4. Silica alkali—Salt glaze stoneware.

5. Earth alkali, or felspathic glaze—Porcelain enamelled stoneware.

This plan of taking the composition of the glaze as the basis seems, on the whole, the most satisfactory, though it has one objection, viz., that it indicates neither texture nor density, because the proportion of the various ingredients is not taken into account, and results widely differing are therefore brought under the same heading. Each of these classes have their distinctive features, which need the attention of the ceramic decorator.

Lead glaze, for instance, is especially liable to trickle and run down the ware, and when compared with *Boracic glaze* under the same conditions this is very evident. The latter, as shown here, keeps its position on the vase, while the lead glaze has run down. This is often the destruction of the underglaze painter's work, lines and bands being liable to slip down with the swimming and falling of the glaze.

Another peculiar property of boracic and soda glaze is the power it possesses of developing the colour in turquoise enamels, and those rich *flambée* (*Sang de boeuf*) effects which are so skilfully obtained in some of the old Japanese wares.

Tin enamels have a quality entirely distinct, producing characteristic effects on the design in which they are employed. The object of the opaque enamel is, in most cases, to obliterate the low colour of the body beneath. Hence the thickness is considerable, and, inasmuch as the fusion of the glaze is not in all cases complete, the modelling of fine details is avoided. Hence the broad effects of all the Della Robbia work. Neither do the colours allow of any strong contrasts of shadow in the hollows, as is the case with coloured glazes. The light being reflected only from the surface, there is a flatness and sameness of effect which, notwithstanding the splendid skill that has been devoted to the decoration, compels us to place it in a secondary position in the list of available materials.

For decorative purposes glazes may be broadly divided into coloured or uncoloured.

In Texture.—(1) Transparent; (2) translucent; (3) curdled; (4) opaque; (5) lustrous.

In Construction.—(1) Dead, or non-reflecting; (2) pitted, or eggshell; (3) brilliant or vitreous; (4) bubbled; (5) crackled.

Decorative Value.

Apart from these distinctive classifications, the decorative value of glazes in ceramic design is a matter of considerable interest, and it is the object of this paper to show that the glaze itself plays a very important part in the artistic result. Beyond this, it may also be demonstrated that the relative merit of various glazes is based upon certain optical principles which have been at present only partially examined by scientists, and that these principles which underlie the pleasurable sensations to the eye, really govern that which we are pleased to call good taste and excellence, so far as glazes are concerned, and are not mere matters of opinion,

The value or utility of a glaze for decorative purposes is affected—

1. By its colour.
2. By its fusibility.
3. By its construction.

1. *Colour.*—The colour of a glaze is obviously of the first importance. Here are various illustrations.

The purity of white seems to be less pleasing in the case of this vase than the ivory tone which blends more fully with the colours of the design.

Here the colour of the whole is harmoniously assisted by covering the surface with this rich, warm orange glaze, blending, with the happiest results, the tone of the design and that of the background, the contrast of which would have appeared raw and cold without it.

In this instance, again, the best possible effect has been secured for the decorator by dipping his work in a warm glaze, which, while softening the outline, has also given strength and tone to the whole.

In all these examples, the glaze has been used merely as a dip, covering the whole piece. But there are further uses of it, which

have been much improved of late years, following the methods of majolica, Palissy ware, and the Grès de Flandres.

In all of them coloured glazes are substituted for pigments, and pencilled over various sections of the design, which is often modelled in relief. Examples of this are to be seen here.

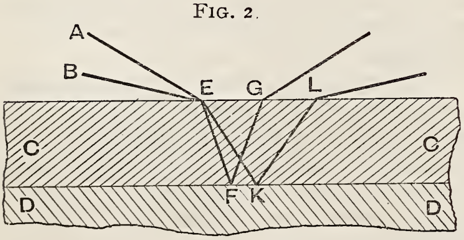
It need hardly be pointed out that in the pencilling of glazes by this method, the details of work are greatly limited. The glaze is generally thick, thus clogging to the brush, and it becomes somewhat unmanageable.

This suggests the query if an equally pleasing result may not be obtained by pencilling pigments only, and dipping after in a transparent colourless glaze. But a moment's reflection will show that the value of the two methods is not by any means the same, and that while gaining in definition and ease of production, there is considerable loss in richness and mellowness of effect, and of satisfaction to the eye.

In order to demonstrate this, let anyone place at the back of a plate of white transparent glass a piece of dark blue paper, and at the back of another thick plate of blue glass of the same tone and thickness, a piece of white paper. In a strong light, the comparison of the two will at once convince the observer that the tone and quality of colour in the latter is greatly more pleasing.

Though it may not be possible to enter here into all the complex details of the amount of light absorbed, refracted, reflected, and scattered in the two cases, it is not difficult to show that what is thus apparent to the eye has its foundation in something more than an æsthetic opinion.

Fig. 2.



Showing Passage of Light through Glaze from two Separate Sources.

Let us presume, for a moment, that the coloured glaze is dipped evenly over a piece of ware, and that its thickness is represented in the diagram (Fig. 2) by C C, the thickness of the ware being shown at D D: now, if a ray of light travels from A, through the coloured glaze, at E, being reflected from the white background of the ware, at F; if, moreover, another ray of light travels from B, through the same glaze, and is reflected from the white background, at K, as before, the angle of incidence, in the latter case, is greater; consesequently, the length of the pathway, E K L, traversed by the ray through the glaze must be much more than the length of the pathway, E F G. The depth of the colour conveyed to the eye by the light passing from A is, therefore, less than that passing from B; and so on from all parts of the object illuminated, the tone value of the colour will appreciably differ in proportion to the angle, thus affording that true sensation of pleasure always resulting from nature's universal law of harmony in variety.

Reversing the method, and substituting a blue background, at F K, and a transparent white glaze, at C C, it will at once be seen, from the diagram, that the relative length of the path of light through the glaze, in each instance, will cause no variation to the tone sensation received by the eye, because the colour of the ray is not in any way affected by its passage through the glaze, the result being that uninteresting uniformity, of which the senses are so intolerant.

I am aware that I have left out of the question the absorption of part of the light, and the scattering of some of the rays, and the action of the convex surface; but I hope I may have been able to make clear the principle involved, and thus to explain that which the eye intuitively appreciates, without the assistance of scientific demonstration.

Fusibility.—The second, and equally important quality affecting the value of glaze, is its fusibility, which greatly affects its power of refraction. All transparent glazes should be fused to the highest degree of temperature which they will bear without trickling down the piece; and, at first sight, it would seem that, provided the glaze is smooth and clear and evenly fused over the whole surface, difference of hardness or density will be immaterial, except on the score of durability.

Such, however, is by no means the case. The higher the temperature a glaze will stand, the greater the hardness; and the greater the hardness, the greater the power of refraction. The greater the refraction the greater the brilliancy of the light reflected back to the eye, and the greater the pleasure appreciated therefrom.

If we place side by side a piece of glass, a piece of rock crystal, and a diamond, the

form and facets of each may be the same, but the eye is immediately sensible of the different refractive value of each, and readily accords to the diamond the highest place.

Precisely the same result is arrived at by comparing a raw faïence glaze, a fritted earthenware glaze, and a Doulton ware or porcelain glaze.

The eye at once experiences the great superiority of the harder glazes.

Nor is the reason of this difficult to understand, though I am not aware that in this respect the relative power of the various glazes have been tabulated.

From the table below (Table 1) will be seen that the density and the refractive power increase very nearly in the same ratio, though it is a fact that the density and the hardness are not always the same, because the material of some soft glazes are very heavy.

TABLE 1.

INDEX OF REFRACTION OF CROWN AND FLINT GLASS IN THE D RAY.

Name of Glass.	Density.	Refractive Index.
Hard Crown	2·485	1·517
Extra light Flint	2·866	1·541
Light Flint	3·206	1·574
Dense Flint	3·658	1·622
Extra Dense Flint	3·889	1·650
Double Extra Dense Flint	4·421	1·710

The diagram below gives the refractive indices compared for various densities and the angles set out for the diamond and other gems. (Fig. 3)

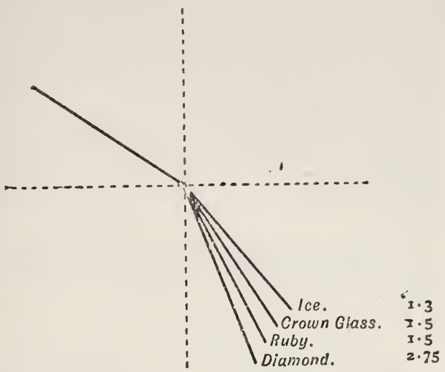
TABLE 2.

INDICES OF REFRACTION.

Name of Material.	Refractive Index.	Density.
Diamond	2·75 to 2·47	3·5 to 3·6
Iceland Spar	1.65	3·6 ,, 2·8
Topaz	1·61	3·4 ,, 3·6
Beryl	1·59	2·8 ,, 2·6
Emerald	1·58	2·8 ,, 2·6
Rock Crystal	1.54	2·8
Crown Glass	1·51	2·48

Now the light in passing from its source through the glaze to the surface of the piece is more or less refracted, and as a certain amount of light is absorbed in the passage through the glaze, it is clear that the rays passing to the eye by the shortest course will have the greatest brilliance.

FIG. 3.

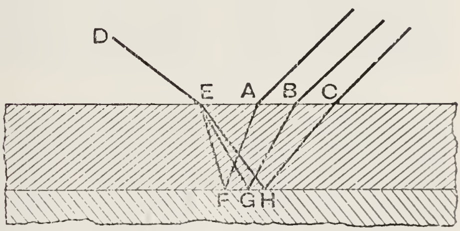


SHEWING ANGLE OF REFRACTION FOR GEMS, &c.

It will, moreover, be found that the most infusible glazes are the most refractive, and, therefore, that the glazes fired at the highest temperatures transmit the greatest amount of light to the eye.

From the diagram (Fig. 4) the comparison of the passage of light through the soft, medium, and hard glazes will readily be seen.

FIG. 4.



PASSAGE OF LIGHT THROUGH VARIOUS GLAZES COMPARED.

3. *Construction.* — Another and equally important consideration in the quality of a glaze is its construction or texture. This greatly affects its beauty, as upon it depends its *translucence*, or power of *reflection.*

(*a*). A glaze may be *opaque*, but it may reflect much light from its surface. Or

(*b*). It may be *translucent*, reflecting scattered light which has penetrated the surface. Or

(*c*). It may be *transparent*, allowing the greater part of the light to pass through it to the ware itself, being reflected back to the eye from the background.

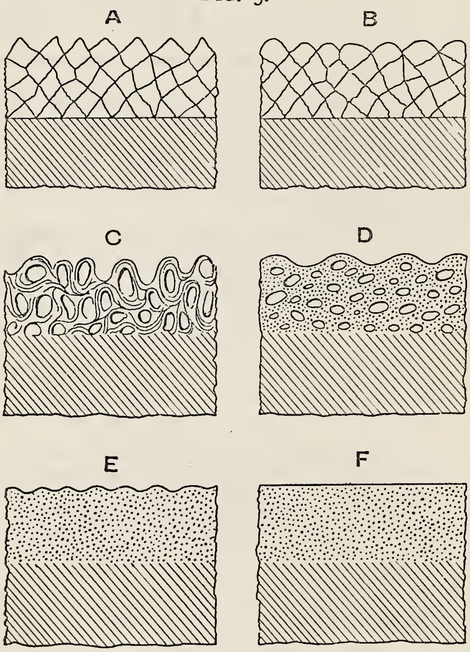
(*d*). And, further, it may be transparent in itself, yet loaded with opaque particles which partially reflect and partially scatter the light, often with the happiest effects, and the richest beauty of result.

(*e*). In addition to all these, a glaze may have imported into it some peculiar quality from the incomplete mingling and fusion of the material, through intentionally firing to an insufficient temperature. This mostly happens with raw glazes.

To appreciate this, it is necessary to follow the history of a piece of glazed work through its various stages, as shown in the diagram (Fig. 5).

A. The glaze being ground in water, is laid on the piece of ware, appearing irregular in surface.

Fig. 5.



Showing Various Stages of Fusion of a Glaze.

B. In firing, the heat increases till the fusion commences by rounding the points. Then the glaze is termed "glanced."

C. Proceeding, if the glaze has not already been fritted, the incipient fusion causes certain chemical reactions, which liberate gases, and these, in escaping, cause the surface to froth and bubble.

D. The gases having escaped, the surface becomes gradually smoother, but the mass is, nevertheless, often filled with small bubbles, which have not had time to escape before the heat has been checked. In this manner trans lucence is caused, or a general appearance o opacity, from the scattering and diffusion o the light.

E. It is only necessary to carry the hea higher to remove these bubbles and caus complete fusion, when a transparent glaze i obtained. To demonstrate this, I call you attention to this vase, which I have caused t be fired partially, with translucent result. Th other half has been in a greater heat, and als received salt vapour on its surface to complet the fusion. It is by this operation changed t a glaze.

F. The glaze is, however, still "pitted," owing to the incomplete firing of the surface and if sharply fired, the final brilliancy o reflection is attained.

Here I pause to note the marked excellenc of the salt-glazed method as used for Doulto ware in accomplishing this result. We hav seen that coloured glaze rather than coloure background gives richness of effect. Also tha the greatest refraction results from the hardes fired glaze. But the hardest glaze is naturall that which is most difficult to bring to a smoot surface. To accomplish this smoothing of th surface, while maintaining the use of a highl refractory glaze, the salt vapour is resorted to and this, while glazing every uncoloured part fuses the surface only of the colour to a sligh degree, and completes that beauty of reflectio by securing the smoothest possible surface t the whole. Nor is this the only interestin matter to be noticed. In the case of othe wares it is possible so to adjust the compositio of the glaze as to cause it to fuse at any re quired temperature, irrespective of the hard ness of the body. But no such arrange ment is possible with salt glaze. It wil be found that, only after securing a tempera ture sufficient to vitrify the body, is it possibl to obtain a complete glaze from the vaporisin of the salt; so that a good salt glaze is i itself, to a large extent, a guarantee of ex cellence in quality of ware.

Doubtless, the difficulties and risks of manu facture are great, chiefly owing to the fact tha it is necessary to expose the ware to the flam of the open fire. It is not, therefore, surprisin that a process so difficult, and needing suc watchful care and experience in its completion should have been gradually abandoned i Staffordshire in favour of the easy methods o dipped glazes and sagger burning; and it i greatly creditable to the enterprise of Si Henry Doulton that, in the face of acknow

ledged obstacles, salt-glazing has again been raised to the position of a fine art, so that its productions are able to vie with, and even surpass, the results of every age and country.

With the most perfect fusion the surface is never quite evenly covered with glaze, the reflected image being always somewhat distorted. Even this, however, gives additional pleasure, by breaking the monotony of the surface. It is only necessary to compare a piece of ware lapidary polished with a piece of ware glazed, to see that the mechanical surface is much less interesting.

By some designers this quantity of brilliant reflection of light from the surface is considered a detriment to the ware, because it is liable to interfere with the design, often entirely obliterating the effect of the work.

It is quite possible to avoid this objection by adopting any of the various expedients for breaking up the reflecting surface. In this example it will be seen that the plain glazed surface of the upper portion reflects the light freely; whereas the surface of lower portion being broken up by the impression of a very fine network is entirely free from this defect, although the whole vase is evenly covered with the same thickness of glaze.

The same effect has been secured by Messrs. Maw in their "Morocco" surfaced tiles, which are made non-reflective by a similar method.

This is a matter of much importance in ecclesiastical decoration. Strongly glazed tiles are open to much objection in obliterating the design by reflection. And the manipulation of enamels and glazes by dulling of the surface in painting and firing is a great gain, giving as in this panel all the effect of tempera work. On the other hand, it is equally possible for the skilful designer to lay hold of this quality of reflection and so add interest by emphasising it.

Here is an instance in which the chief quality of the design depends on the high reflective power of the surface. It is only necessary to compare it with this unglazed piece of similar design to appreciate the great superiority of the former.

Doubtless all these various qualities, the subtle combination of which together constitute the beauty of any given ware, may appear to be minute and even trifling, but the very minuteness of the variations, together with the complexity of the results, are in themselves a source of satisfaction. The extremely sensitive organism of the human eye gives it the power to appreciate the most delicate and subtle changes of light, colour, and form, and the sense of this power, as well as the very opportunity of exercising that refinement of discrimination, is in itself a means of infinite mental enjoyment.

As to the ear, the musical inflexions of the human voice are the means of ceaseless delight, so to the eye gradations of tone, colour, translucence, and reflection afford the unlimited possibility of pleasurable sensation; and for this reason they enable the potter to appeal with unfailing interest to the artist and the connoisseur.

It has thus been shown that excellence of glaze is greatly attributable to high firing, which adds brilliance and beauty to its texture. So much does the eye become, in time, accustomed to appreciate this quality, that it is possible to form a fair estimate of it without close examination or handling the piece itself. Yet, after all, there is in this same excellence a pleasure even to the touch, and one begins to realise that the old joke of "living up" to a piece of blue china is not so far-fetched after all; and the collector who goes about fondly stroking a choice piece of "Nankin" has, notwithstanding all our smiles, strong arguments in favour of his fond appreciation.

There is still another point which demands attention before leaving this part of the subject, viz,, the *scattering of light*, due to the character of the background immediately underlying the glaze; a matter which, in its influence on the artistic result, is by no means unimportant. It must be evident to all that it is possible to leave the unglazed surface of the ware in a variety of conditions before covering it with glaze.

(*a*.) It may be roughly formed without any attempt to smooth it carefully; or

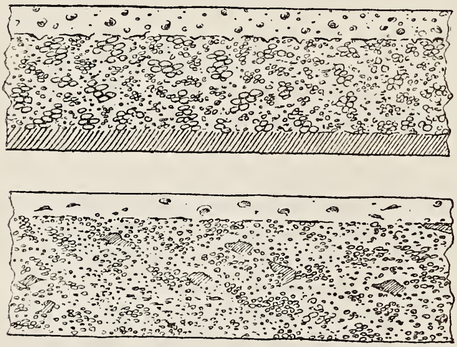
(*b*.) It may be completely burnished, so that the surface is to a great extent impervious to the glaze fusion; or

(*c*.) The surface may be purposely formed of coarse granular particles, leaving an irregular formation on which the glaze is deposited, and into which it fuses.

Here are specimens of all these methods, and the diagrams (Fig. 6, p. 302) will show approximately the result after glazing and firing. The last of these will best illustrate the scattering of rays, viz., the Persian tile, in which the background is almost crystalline.

It has been customary to make these tiles of about 90 per cent. of coarsely-ground fragments of silica or rock crystal, cemented together by about 10 per cent. of clay and glass. In the case of Damascus tiles this is a pure white frit, mostly glass and alkali. The surface of the tile so formed is naturally very irregular, and the glaze fuses into the interstices, forming a background which partly scatters the light with that charming effect so well known and admired. It is only needful to compare these examples with the modern French imitations, or with Dutch enamel tiles, to see how far more artistic is this effect of the former.

Fig. 6.



With regard to the blending of the background into the glaze, this is much affected in all cases by the preliminary treatment of the ware. If the glaze has been fritted, and the ware biscuited, there is much less intermingling and fusion of the two at the surface of contact. But in cases where the body is unburnished, and is fired with a raw glaze upon it, at one operation, the line of demarcation between the two is very undefined, and the result proportionately softer in effect. It is probable that much of the beautiful Japanese Celadon ware is produced by such means.

The soft translucence of porcelain is greatly due to this intimate blending of the glaze and body, uniting the whole into one mass, having no sharply dividing line between the two, so that when the light penetrates the transparent glaze, it is reflected and refracted from the surfaces of the minute crystals resulting from the combination of the clay body with felspathic flux.

In beauty of texture, the material is unsurpassed, uniting, as it does, all the highest qualities of the potter's art; an enduring evidence of the triumph of human skill and persistence in conquering the most serious obstacles which stand in the way of its successful production.

It is hardly necessary to remind the decorator that the material to be employed, as well as the tools and appliances for carrying out the work, must greatly modify the treatment. Especially is this remark true in respect of pottery glazes. The design which might prove admirably suited for underglaze work on bisque must be wholly unfit for painting on raw enamel; and, for many reasons an artist is compelled to inquire, before proceeding, the nature of the glaze to be used for the completion of his work, unless he wishes to run the risk of hopeless disappointment in the result.

It is from this consideration only that I have ventured so fully to enter into details which in themselves, may appear somewhat unimportant.

Decorative Application.

Having thus far treated of the characteristic, which, for purposes of decoration, give value to a glaze, and, at the same time attempted to explain some of the principles to which those peculiarities are due, I may perhaps be allowed to draw attention to a few examples of the successful application of various glazes on the embellishment of pottery.

A.—Subordinate Treatment.

In many instances, the designer is naturally led to subordinate the glaze entirely to the main features of his work, using it as a means of adding brilliance to his result, or of imparting a soft translucence. A comparison of the two methods is furnished by these beautiful examples of Worcester porcelain, and that of Messrs. Copeland. In the first, the ivory toned ground is made the field upon which gold enrichments have been added, the translucence greatly assisting the beauty of effect; while, in the latter, brilliant transparency and purity of the glaze serves to give piquancy to the whole; or, to take another instance, it is interesting to note the same skilful subordination of glaze to its purpose in the treatment of this exquisite design by M. Solon. The soft and tender fading of the half-tones into the background is greatly enhanced by the rich glazing, which, however, does not interfere with the delicate modelling of the subject. Comparing this, again, with the vase here shown, designed by Flaxman, it is not difficult to apprehend the reason for the different treatment of the modelling adopted. Having no

intention of glazing, the artist has trusted alone to the pleasant translucence of his material to overcome any harshness of effect. Looking at the two examples, one feels that it would be as unpardonable to add the glaze to to one as to remove it from the other.

It must occur to the least initiated that the comparison of advantages in painting over or under the glaze, is most important to the ceramic designer.

For endurance, and for softness of tone, the underglaze system is undoubtedly superior; nevertheless, the palette thus becomes limited, and many otherwise available effects must therefore be discarded. Moreover, in some cases the placing of colour or gold over the glaze heightens the beauty by enabling the eye to more fully appreciate the translucence or the thickness and tone of the glaze beneath.

In this example, the gilding on Doulton ware glaze gives a sense of satisfaction from the same cause.

Equally pleasing is the gilding on this vase of "Crown Lambeth" ware, which also affords an illustration of a somewhat different manipulation.

The design mostly painted on the biscuit is, after glazing and firing, retouched and worked up with underglaze colour, being again glazed and fired at the same heat. The blending of the finishing colour with the glaze, in which it is thus entirely embedded, while affording some considerable risk for the decorator, gives a soft and mellow gradation of tone which can hardly fail to commend it.

Midway between the "subordinate" and what may be termed the "principal" use of glaze as a decoration, one finds a class of treatment involving the use of glaze in harmonizing or mellowing the tone of the whole design by a variety of methods. The simplest of these is, perhaps, the adoption of a "crackle glaze," as in the well-known Satsuma ware. It is not necessary to expend time on explaining the different adjustment in shrinkage of the body and glaze which causes this. It may be sufficient to point out that, in cooling, the whole surface is broken up into a net work of small cracks. The reflection of light thus obtained on the edges of the fractures acting as facets breaks up the plain surface and tends to add brilliancy as well as harmony to the whole. A good example of this effect is to be found in many of the wall tiles produced by Mr. De Morgan.

Another expedient for the same end is to be formed in the covering of the surface with a coloured glaze, giving a certain tone to the whole as previously mentioned.

In the example here shown, the beauty of the work is greatly enhanced by the rich green glaze in which it has been dipped.

A third method is illustrated by this piece of Lambeth Carrara ware. A white background is decorated in green slip, the hard contrast of the two being subdued by covering the whole with a semi-opaque glaze, which tones the colour while it emphasises the brush modelling.

B.—Principal Treatment.

Passing on to the use of the glaze itself as a principal decoration, we note many interesting and ingenious adaptations.

The use of broken colour alone, combined with small crackle, affords the *motif* for the well-known and much prized tortoiseshell ware of Wedgwood, as also in the beautiful specimen of Aventurini glaze of French manufacture, resulting from the combination of iron and copper with an alkaline glaze. Also in these reproductions of the Japanese tea jars in Doulton ware.

The lustrous surface gives sufficient interest to the beautiful production of Beleek and other similar pottery, while the movement of the surface is illustrated in this specimen of the ware of Japan; and in this we have another very peculiar and striking instance of glaze treatment.

The glaze, having crazed at an early stage of the firing, gradually contracts until each minute section shrinks away from its neighbour and becomes a small round drop, giving the whole the appearance of peach-stone or nutmeg surface.

A further and striking development of the same idea is here shown in another method. The glaze is first of all formed into small, glassy beads, and these are embedded in a coating of glaze dipped on the pot while the same is wet. After firing, the refraction of light gives from some points of view a very singular and brilliant result.

Here, again, is an altogether different adaptation of the material instanced in these delicately skilful productions of Messrs. Minton. After finely perforating a design in the ware, the piece, when fired, is covered with a glaze sufficiently thick to fill the interstices with the most charming and artistic result.

Almost all the above have as their basis the desire to produce satisfaction to the eye by

variety and contrast through the breaking of the surface of the colour of the glaze.

A very happy and extremely delicate combination of both treatments is well illustrated by the "mother of pearl" background, a clever and ingenious texture lately produced on Messrs. Doulton's Burslem china. Its iridescence, although apparently similar to lustre, is altogether distinct in the method of production, as will be seen on close examination.

Altogether different from the modes already named is the filling of an intaglio design with a soft glaze. The ware is horizontally fired, and the coloured glazes flowing to a uniform level during fusion, produced a shaded effect, according to the varied depth of the design.

Here are very characteristic examples of this method.

A similar operation, but upon a modelled surface, is here adopted.

It has been my desire in thus limiting attention to one section only of the potter's work, to arouse, at the same time, in the ceramic designer a wholesome pride in his material, and a true respect for his handicraft.

Nothing short of complete excellence and thorough honesty of workmanship in the potter's art can withstand the searching test of that extreme fire necessary to produce the most perfect and enduring result; and, as in other spheres of life so in this, disintegration is the ultimate penalty of all that is false, and superficial, and immature.

Nor is it possible to avoid the conviction that, for the attainment of the highest perfection, there must be added to this honesty of purpose that absolutely harmonious co-operation of each towards the final result, which is the truest ideal of human existence.

Pottery consists of a chain of operations, in which there are many links; each process in itself complex, and in its principles far from completely comprehended. Yet the failure of any single link brings disaster and dismay, wrecking the willing work of all that have gone before.

Notwithstanding this, the triumphs of pottery in China, Persia, and Japan, are marvellous, not merely as creations of beauty, but as examples of what may be accomplished by means so primitive, and methods so simple, that they would seem to be within the grasp of every beginner. Yet one is humbled by the reflection that, notwithstanding all the advances of science, and all the perfection of modern mechanical appliances, added to the combined experience of a hundred generations, the achievements of these Oriental potters have baffled all the efforts of modern times to equal or surpass them.

Nevertheless, in this we find no cause for disappointment; rather let us take courage in the fact that in pottery, as in other arts, the path to success lies in the painstaking discrimination of results, and the unbounded ambition to arrive at the highest standard of excellence, scorning to be satisfied with aught that falls short of the ideals we have set before us.*

DISCUSSION.

The CHAIRMAN said this was a most interesting and valuable paper, full of information and suggestion. Even those who were not potters could appreciate the important part that glaze played in the beauty, harmony, and durability of pottery. There was one popular misconception with regard to glazing which he should like to dispel; a bright glaze, as a rule, gave no security for durability, and he did not think the potter's difficulties in this respect were sufficiently appreciated. To take a simple illustration, a common Sunderland milk bowl with a beautiful cream-coloured glaze inside, was very nice to look at, but the body on which the glaze was run was comparatively porous, and it would be seen, if any housekeeper attempted even to salt anything in that pan, that the glaze would come off; it would not require even acid to take it off. The glaze was beautiful enough, but the body itself was lacking in hardness. Sometimes these bright, beautiful, coloured pieces were hard in body as well as hard in glaze; it was that which taxed the potter's ingenuity and skill to accomplish. Mr. Rix spoke of the links there were in the potter's art; and, in fact, there were a good many, and the strength of a chain was only that of the weakest link—a proverb which all potters could thoroughly appreciate. The potter might have forged the whole chain, and then the last link failed him, and the whole work was a failure. The great merit of the paper, and the originality of it, was in showing the optical laws which had not previously been noted in connection with the beauty of glazes, and he felt certain that an optician following out the line of argument he had suggested, would come upon certain principles which, if attended to, would make a piece of pottery beautiful. No doubt the Orientals, by tradition and otherwise, had arrived at results which we had to arrive at by scientific methods. He might mention, as

* I am much indebted to those who have so courteously allowed the use of valuable specimens as illustrations, viz., Messrs. Phillips, of Oxford-street; Mr. Litchfield, Hanway-street; Messrs. Daniels, Wigmore-street; Messrs. Maw, Mr. De Morgan, and Mr. Wenger; also to Sir H. Doulton, for the loan of important examples from his private collection.

ı illustration, a tile panel which he had the good ›rtune to possess; a Persian panel which Mr. parkes first directed his attention to. It had ıat beautiful effect of translucency in a most minent degree, and it was borrowed by Mr. 'urdon Clarke to place in the Indian collection t the Paris Exhibition of 1878. In the course f the Exhibition he heard that Mr. Deck, the great 'rench potter, wanted to see him, and it turned out hat he wanted to purchase this panel, and though he old him he did not want to part with it, he saw im three times about it, pressed very hard, and said ıe would not only give a very good price for it, but vould make him one which he would be hardly ble to distinguish from it. One remark in the paper vas with reference to the touch of pottery; and that eminded him that a gentleman who highly appreciated Wedgwood ware, Mr. Edkins, of Bristol, sitting y his side one day at Christy's, said he judged more y the touch of Wedgwood than by anything else; that ıe could rely on that quite as much as his eyesight. With regard to the salt-glazed ware, it might ıot be generally known that it was applied 25 years ago only to the commonest ware—to ginger-beer bottles, blacking bottles, and drain-pipes. At one time Bristol and Lambeth were the great centres of the salt-glazed pottery trade, but there was not a single salt-glazed pottery in Bristol now, and in Lambeth it was fast going out; and but for drain-pipes, and his own love of it, it might perhaps have gone out altogether. It was a most interesting glaze, utterly unlike any other. It was something ike electrotyping, or, rather, was superior to it, because electrotyping was the deposit of one metal on another; whereas, salt-glazing was an actual action of the vapour on the silica itself, and so the glaze was actually the body itself fused. The difficulties of it only a potter could appreciate. It was worked in an open kiln, without any sagger to cover the pieces, and with all the gases from the coal playing about them. The consequence was, that in that very beautiful little piece of Mr. Tinworth's which had been shown, which illustrated what was possible at that time, the blues were black, and for a long time they could not get a blue at all. The whole range of colours possible in salt-glazed ware were shown in the specimens exhibited. In 1750 or 1760, in Staffordshire, glazed ware of this kind had arrived at great perfection; it was fired, not in an open kiln, but in saggers with holes in them; and if anyone came across a piece of that kind at a reasonable price, he should advise him to secure it; for he did not think any more would be produced. The finest collection of it belonged to Professor Church, and it was destroyed in the fire at the Alexandra Palace. In conclusion, he would only say that science and art were not antagonistic, and Mr. Rix had in his paper shown how they should be combined.

Mr. Lewis Day would not have spoken unless called upon, as he knew very little about practical pottery; but he should go home feeling that he knew much more about it since hearing Mr. Rix's valuable paper. The reader of the paper had explained to him the reason of many things he had always felt about pottery, his preference for hard ware, for example, and for ware generally which proved to be fired at a great heat. He was especially grateful to Mr. Rix for giving him a reason for his dislike for the colour of Della Robbia ware, so much more enjoyable in the photographs than in the coloured ware itself; and he would be still more grateful to him if he could explain to him his yet deeper dislike for the nasty, sticky colour of Palissy ware; to him it was positively loathsome. He wondered whether the superiority of painting in glaze over painting in enamel colour was not in some degree attributable to the thickness of the glaze, and to the consequent inequality of the surface of the ware? With regard to crackle, he would like to know how far it actually added to the perishable nature of the pottery. Finally, it occurred to him to wonder how it was that, with the old Chinese blue and red before us, we did not more often depend upon the beautiful colour of the glaze itself for decoration, instead of painting landscapes or pretty faces, or even ornament upon earthen vessels. Was it because we could not get the effects produced in Oriental ware, or was it that, commercially, it was not worth doing?

Mr. Frederick Litchfield said there were many interesting points arising out of this paper, and one in particular was rather perplexing to his mind. He understood from Mr. Rix that the great desire of the potter was to achieve a hard body and a hard glaze. It might be prejudice, but he had been brought up in a school where the highest prices and the greatest merit were awarded to old Sèvres of soft paste. He knew that if the same decorations were placed on a hard body, as was the case with Dresden porcelain, as on the old *pâte tendre*, the effect of both decoration and colour was entirely different. He believed it was impossible to get the same turquoise as he saw on a cup and saucer on the table, or even the Rose du Barri and one or two other colours, on a hard body as on a soft body; and he should like to have that explained if it were possible to do so. He wished to add his tribute of praise to that of Mr. Lewis Day.

Mr. Binns said he should be very glad if Mr. Lichfield could show him how to get the old Sèvres turquoise and Rose du Barri. They were always trying to get it, but had not yet succeeded, and he did not know whether they would. He thought it was Mr. Gladstone who said once that a fine piece of glaze felt like the touch of a baby's hand; and he had often been struck with the aptness of the illustration. There was a peculiar soft texture in a fine piece of glaze that only a connoisseur could appreciate. With regard to the crackled surface, he had little doubt it was an accident, and then the maker,

seeing the beauty of it, turned it to advantage. A distinction must be made with regard to that between ornamental wares and useful. It might be beauty in ornamental ware, but in plates and dishes it was distinctly a fault, because every crack was a means of absorbing whatever might be used on the surface which could never be removed by any amount of washing. He must confess to being a little sceptical about Mr. Rix's views with regard to the refraction of glazes. He did not know whether he had arrived at those conclusions from practical experiments, or whether it was merely a theory of his own which he sought to prove by the elaborate diagrams ; but he failed to see how the different angles of light could be arrived at. He did not profess to be an optician, but he had some claim to be a practical potter. There was no doubt some glazes had more depth than others, and some were more transparent than others, and he thought these views should be pursued a little further. The difficulty was increased on account of the extraordinary thinness of the glazes through which the ray of light had to pass. Of course, mathematically, that ought to make no difference, but he thought it really did in practice. He saw the point with reference to the coloured glaze very clearly, and he thought it was possible, for a ray of light to pass through a coloured glaze in differeut directions, and, therefore, to give shades of colour, but that one glaze reflected light differently to another, simply because of difference in composition, he was not prepared to admit without further demonstration.

Mr. SPARKES said when he came that evening he thought he knew a few things about pottery, but listening to the paper had made him feel that his knowledge was but a speck in comparison with the vast abyss of ignorance in which he seemed to have existed. The subject had been treated in a masterly way, and was also very interesting from its suggestiveness. The optical question had only been touched upon, but there was evidently a practical future for further investigation into it. It seemed to him there was very good reason why the double ray coming through the coloured medium would have a better quality than the same ray coming from a blue background through a white medium, and that the quality of transparent glaze coloured must be very much greater than transparent colourless glass put over a coloured background. This was a point which should be worked at by someone, and if it were followed up he thought that probably the enormous pleasure which a china-maniac felt in nursing his favourite teapot would be explained. One additional point which occurred to him as Mr. Rix's paper showed the difference between a tile of Persian glaze and a modern imitation. He remembered an experiment which was perfectly well carried out in Paris some years ago. A beautiful Persian vase had become chipped, and the soft interior stained a good deal, probably by bad usage. The French experts attached to the Louvre conceived the idea of was[h]ing out the body between the two skins of glaz[e] and they succeeded in doing so. They actually di[s]solved away the discoloured interior between t[h]e outer glaze and the inner ; the whole of the colo[ur] applied to the ground had come up into the glaz[e] nothing was lost, and the discolouration was replac[ed] by an appropriate body, and this very beautiful va[se] was restored to its original state. This showed wh[at] an important factor the glaze was. In this case [it] was the main thing—the body was nothing but [a] support. Of course that would be only possible in [a] pot which had a soft body, and outside it a perfectl[y] continuous glaze. He had found that some of thes[e] Persian tiles looked as if a piece of glass ha[d] actually been melted down on the surface, so eno[r]mously thick was the glaze. That thickness was on[e] of the greatest factors to the pleasure one had i[n] looking at a piece of Persian ware; it was th[e] depth through which the rays of light passed t[o] the background that was missing in the moder[n] ware completely. When one considered the enor[]mous number of combinations which could b[e] made between the body and the glaze, betwee[n] the surface of the body and the texture of the glaze between the colour of the body and the thickness o[f] the glaze, and between the thickness of the body an[d] the colour of the glaze, one became aware o[f] the infinite combinations that were possible, an[d] no doubt the infinite combinations were the sourc[e] of that great pleasure which all the world appeare[d] to have had in pottery. From the first tim[e] pots were made, he believed there were collector[s] who kept the beautiful pieces. It was a craze at th[e] present day, but it existed all through the Middl[e] Ages, not only in Europe, but in the East, even to a greater extent, and he believed it was a justifiabl[e] lunacy.

Mr. CECIL SMITH said he had come entirely as a learner. His principal occupation was in dealing with the pottery of the ancient Greeks, and the study of Greek glazes was not one which promised to add much to our stock of knowledge, because, he believed, up to the present, they had still failed to analyse exactly the glaze which the ancient Greeks used. He believed the exhibition of vases in the British Museum was interesting to potters from this point of view, that they afforded an admirable example of the gradual introduction of glaze in the way they were arranged. They were placed so as to show how the use of glaze gradually grew up. In the first phase of all was the earliest hand-made ware from a time when people were still using stone implements, and used very little metal of any kind; here they simply made pots of the rudest kind, with very little form about them, and no use of the wheel at all. Then they got gradually to hand-polished ware, and with regard to that, the usual theory was that the polish was facilitated by the use of some kind of juice applied to the surface. Then there came

in that extraordinary blue lustre glaze which the Greek potter developed in its highest form. He believed he was right in saying that practical potters had asserted that the glaze on the Greek vases, the composition of which was practically unknown, was considerably thinner than any glaze known to moderns at all, and that it was also very nearly as hard as any known glaze. With regard to the remarks of Mr. Sparkes, he came across a curious fact the other day, which looked as if some of the old Greeks had been interested in collecting pottery. A Greek tomb was found some time ago at Bari, which contained no less than 155 fragments of old Greek vases. They were all so small that nothing of the decoration upon them could be made out; they seemed all to belong to different vases, and it seemed impossible to understand what could have been the reason for putting all these fragments into the tomb, unless, possibly, the tomb had been that of an ancient collector of pottery, and he had had these specimens buried in the tomb with him.

The CHAIRMAN then proposed a hearty vote of thanks to Mr. Rix, which was carried unanimously.

Mr. RIX, in responding, said, with regard to the decoration of pottery which Mr. Lewis Day spoke of, he was afraid that the taste in this country was still largely in favour of the landscape and *naturalesque* treatments, which he objected to, though it was very disappointing that it should be so. Mr. Litchfield had spoken of old Sèvres with a soft body, and he wished he could inform him—and he thought Mr. Binns, and many of his fellow potters would very much like to able to explain these things—because it would be the key to the whole matter, and enable them to produce that which they so much longed for. But the old Sèvres pottery was mostly kept in cases rather than for use, but all must feel that there was greater endurance in bodies which were harder. In answer to Mr. Binns's sceptical remarks, he would say that he had touched on this optical question very late in the day; it did not occur to him in the earlier stages of dealing with the paper, and he had no time to verify his ideas, nor had he the apparatus, which would be necessarily very expensive and delicate. He, therefore, took the only opportunity he had of referring to two of the ablest authorities on optics, and to some extent they endorsed his views, but they confessed that this region was altogether unexplored. They did not altogether commit themselves to any opinion on the point which Mr. Binns was sceptical about, and he could only say that it formed a region which was suggestive to those who were more able than himself to deal with. He could hardly agree with Mr. Binns as to the thinness of the glaze being too minute to be appreciated by the eye. The eye was an extremely delicate organ, and he thought it would be found that it did apprehend delicate inflections and minute distinctions, and it was in that way that the beauty of the whole thing was appreciated by the eye and by the mind. He did not think they were quite able to say what was the composition of the surface of the old ware which Mr. Cecil Smith had spoken of. They had not arrived at the way in which the Samian ware was glazed in all cases, but he hoped by further examination of these things they would arrive at many of those points which only served to illustrate how many-sided a subject pottery was, and how extremely interesting in all its phases it was to those who inquired into it.

TENTH ORDINARY MEETING.

Wednesday, February 15, 1893; SIR FREDERICK ABEL, K.C.B., D.C.L., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Hopkins, Thomas John, Cradle-bridge Works, Trowbridge, Wilts.
Murzban, Khan Bahadur M. C., C.I.E., Bombay, India.
Skudder, G., 12, Belmont-park, Lee, S.E.
Thompson, Harry J., Arkonan, Madras, India.
Watson, F. T. G., M.Inst.C.E., C.I.E., Lucknow, India.

The following candidates were balloted for and duly elected members of the Society:—

Blakely, William, Melville, Queen's-road, Boscombe-park, Bournemouth East, Hampshire.
Church, G., Building Works Office, Royal Arsenal, Woolwich.
Crackanthorpe, Montague, Q.C., D.C.L., 65, Rutland-gate, S.W., and Newbiggin-hall, Westmoreland.
Eyres, Henry Charles, Millfield-cottage, Millfield-lane, Highgate, N.
Gibbons, Charles Preston, 5, Marine-parade, Gravesend.
Grindle, George Annesley, 8, Great Winchester-street, E.C.
Laing, John, 3, Mentone-terrace, Newington, Edinburgh.
McCullough, Frederick William, 7, Chichester-street, Belfast.

The paper read was—

ON THE DETECTION AND ESTIMATION OF SMALL PROPORTIONS OF FIRE-DAMP, PETROLEUM VAPOUR, AND OTHER INFLAMMABLE GAS OR VAPOUR IN THE AIR.

By FRANK CLOWES, D.Sc.Lond.,
Professor of Chemistry in the University College, Nottingham.

INTRODUCTORY.

The serious calamities arising from colliery

explosions, and from explosions in petroleum ships and stores, have in recent years been very considerably reduced in number. This is largely due to the enforcement by Government of proper precautions.

One of the first requisites for avoiding danger is a suitable process for detecting and estimating the inflammable gas or vapour in the air. The ordinary method of testing, which depends upon observing the pale "cap" formed over the reduced oil-flame of the safety-lamp in the presence of "gas," is no longer sufficiently delicate for modern requirements. This test, when carefully performed, will detect with difficulty 2 per cent. of fire-damp in the air of the coal-mine; less than 2 per cent. is not detectible by the ordinary safety-lamp. Yet it is necessary for certain purposes to detect and estimate 1 per cent., and even less, of fire-damp.

The testing of the general condition of the air of the whole mine is most rapidly effected by the examination of the "returns," or air-currents which have passed through the mine and are on their return-way to the surface. The "returns" should not contain more than 0·5 per cent. of fire-damp. If 1 per cent. is exceeded there is an abnormal escape of fire-damp occurring in some parts of the "workings," and further detailed examination becomes necessary. This useful check on the state of the mine cannot be applied by any ordinary safety-lamp.

The ordinary safety-lamp is also useless for ascertaining the safety of a "dusty" mine, since it has been shown by W. Galloway that air containing less than 1 per cent. of fire-damp is explosive if coal-dust is also disseminated through it.

Accordingly other forms of gas-testing apparatus, exceeding in delicacy the ordinary safety-lamp, have been brought forward during the last twelve years. I have to-night to give the results of experiments with the various forms of apparatus now in use, and to propose a new method, which seems likely to rival, if not to supersede them.

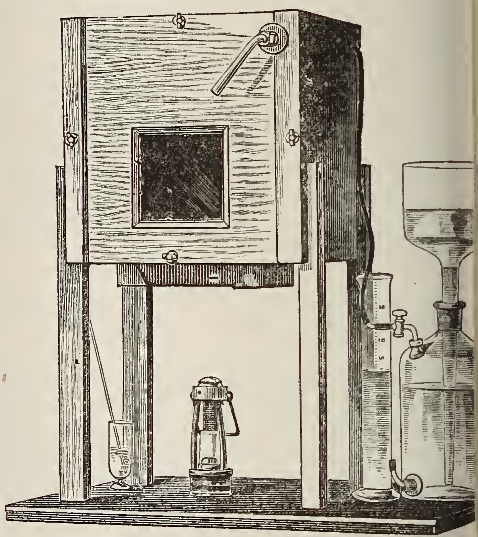
Requirements of Delicate Testing-apparatus.

It may be stated at once that the testing-apparatus must be judged mainly on the following grounds:—

1. As regards its convenience.
2. Its capability of serving, when requisite, as an illuminator in the darkness of the coal-mine.
3. Its safety in the presence of fire-damp.
4. The accuracy and range of its indications and measurements of gas.

The first three considerations have been pretty fully worked out already with regard to existing testing apparatus, but the fourth seemed worthy of careful investigation in connection with the existing and the newly-proposed apparatus.

Fig. 1.

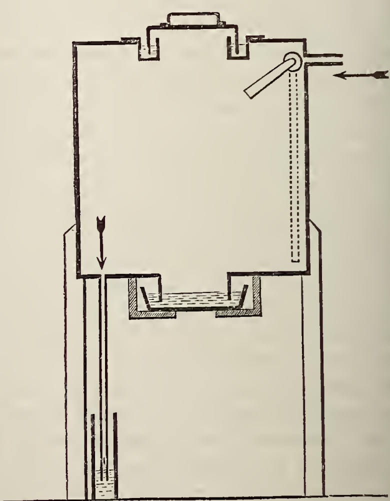


Test-chamber.

The Test-chamber.

Since the examination had to be conducted in a chemical laboratory, and a supply of fire-damp from the coal-mine was not available, a

Fig. 2.

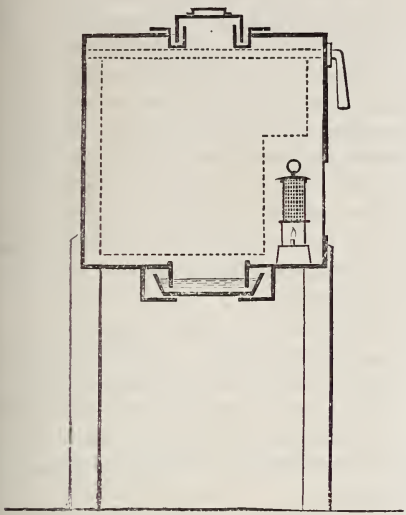


Test-chamber (Section).
(Front.)

special apparatus had to be devised which would economise the artificially prepared fire-damp, and which would, at the same time, be quick and convenient in use.

The "test-chamber," which has served admirably for a long series of these investigations, consists of a gas-tight wooden box, of 100 litres capacity (Figs. 1, 2, 3). It is provided with a glazed opening in front, and is mounted on a stand, of sufficient height to bring this window on a level with the eyes. The box is provided with a small opening close to the top of one side, by which a measured quantity of the light gas can be introduced from a gas-holder. The air thus displaced from the chamber escapes through another small opening by means of a tube, the end of which just dips beneath the surface of water so as to seal it. The gas is mixed with the air in the interior of the chamber, by swinging a light wooden flap suspended within one of the upper corners of the box, and nearly equal in surface to the section of the chamber. Both the floor and the roof of the box are provided with square openings, which can be closed with water-seals. The lower one serves for introducing the lamp into the chamber. The upper aperture, when opened at the same time as the lower one, allows the chamber to fill itself with fresh air in the short space of two minutes after the completion of a test. The introduction of the lamp can be effected before the chamber is closed and the gas is admitted, since the mixing-flap is cut away, to admit of the lamp standing just behind the window during the process of mixture. But the lamp may be safely inserted after the mixture has been made, since it was found that, when the lower aperture remains unclosed for five minutes, no appreciable alteration occurs in the composition of the atmosphere of the chamber.

FIG. 3.



TEST-CHAMBER (SECTION).
(Side).

The capacity of the test-chamber is sufficient to permit of the small testing-flame of an ordinary safety-lamp burning in it for at least half-an-hour, without any perceptible alteration taking place in the size of the flame-cap.

The lower water-tray, which closes the opening in the floor, is slung from the bottom of the chamber in such a way as to be easily moved aside and brought back without losing its horizontal position. The upper seal is closed by a deeply flanged lid, dipping into a square water channel, and held down by buttons.

A small circular hole is cut in the floor of the chamber to permit the bottom of the lamp to be reached, and the wick of the oil-lamp to be adjusted by the "pricker" from outside while the chamber is closed. This hole can be closed by a suitable hinged flap.

When a mixture of air with 1 per cent. of fire-damp is required, the gas-exit of the gas-holder is connected with a sufficient length of rubber-tubing to enable it to be placed in communication with the upper hole in the chamber. The gas-tap of the gas-holder is then opened and the air is thus displaced from the flexible tube, and the pressure within the gas-holder is at the same time allowed to fall to that of the atmosphere. The upper end of the rubber-tube is then closed with a spring clamp, and connected with the upper opening into the chamber. One litre of water is poured into the top of the gas-holder, the gas-tap and flexible tube are opened, leaving a free entrance to the chamber, and the measured volume of water is allowed to flow into the gas-holder: the water-tap of the gas-holder is then closed. As soon as air ceases to escape from the chamber exit, the flexible tube from the gas-holder is closed near the chamber. After the air and gas have been mixed, the chamber will contain air in which exactly 1 per cent. of gas is present. Other per-centages are introduced in a similar way; the quantity of gas entering the chamber being determined by the volume of water poured into the top of the gas-holder.

If the gas to be mixed with the air is heavier than air, it is introduced by the *lower* side aperture of the chamber; and if the gas or vapour is soluble in water, the aperture in

the floor of the chamber is closed on the inside by the falling down of a hinged wooden flap, which covers the water in the tray from the atmosphere within the chamber.

Mixtures of air, with known per-centages of any gas or vapour which is much lighter or much heavier than the air, are obtained with great accuracy by this means. But the apparatus is by no means as well suited for making mixtures containing a gas, like carbon monoxide, which is of about the same density as air. In this case, some further special contrivance for preventing the mixture of gas and air taking place while the chamber is being charged, is necessary.

Observations on the Comparative Delicacy and Accuracy of Different Testing Apparatus.

The apparatus devised for accurate and delicate gas-testing depends on three different principles.

1. The first principle is the increase in brightness produced in a platinum wire heated to dull redness by the passage of an electric current, when the wire is surrounded by air containing gas.

The apparatus depending on this principle is that devised by E. H. Liveing (Phys. Soc. Proc., June, 1880). The apparatus is certainly most delicate as a gas-detector; it presents the disadvantage of not serving for illumination; it must, therefore, be accompanied in the mine by a safety-lamp; and since, in its present form, it is somewhat heavy and cumbrous, it becomes a serious addition to the load of the gas-tester. Opinions differ regarding its absolute safety in the presence of high per-centage of gas.

Per-centage of Methane (Fire-damp) present in Air.	Per-centage indicated by Liveing's Apparatus in several Experiments.
0·05	0·05 (several experiments)
0·11	0·11, 0·13, 0·12, 0·11
0·165	0·150, 0·140, 0·300, 0·330 0·300, 0·200, 0·220, 0·220
0·225	0·230, 0·320, 0·280 0·320, 0·260, 0·260
0·275	0·200, 0·400, 0·280, 0·380 0·300, 0·280, 0·370, 0·320 0·250
0·300	0·300, 0·340, 0·380, 0·470 0·330, 0·350
0·5 to 2·2	Results of remarkable accuracy were obtained.

As regards the delicacy and accuracy of this instrument, Mr. James Grundy, of Bolton, working with my test-chamber, has obtained the foregoing results

Mr. Grundy complains that the platinum wire undergoes a change when in use, which is partly due to an alteration in its electrical resistance, and which altogether changes its standard indications. An adjustment thus becomes necessary, which is sometimes beyond the limits possible in the apparatus. Many operators have also found that the wire is easily fused by the application of too strong a current, or by the high temperature produced by exposure to a high per-centage of gas. The instrument is then useless until a suitable wire can be obtained to replace the damaged one.

2. The second principle applied to gas-testing is that of noting the decrease of pressure caused by burning out the inflammable gas or vapour.

This is effected in a closed vessel, connected with a pressure gauge; a metallic wire within this vessel can be maintained at bright red-heat for a short time by the passage of an electric current, and serves to burn the gas or vapour completely at the expense of the oxygen in the air.

This apparatus, originally introduced by Coquillon, has been modified by Le Chatelier, by Maurice, and by Sawyer. It appears to be accurate and delicate, but is not largely adopted; the reasons probably being that it is not convenient, it is not an illuminator, and its safety in the mine is doubtful, since electric sparks might be produced from the battery used.

3. The third principle applied to gas-testing is the production of a pale "cap" over a non-luminous test-flame, when sufficient gas is present in the air.

This is the oldest test, and was originally applied by trimming the wick of the miner's candle, and then looking for the flame-cap whilst shielding the light of the flame from the eye by the hand. The test was still adopted, after the introduction of the safety-lamp, but in a safer fashion, by pulling down the wick of the Davy lamp, until the flame became pale blue and non-luminous, and then examining its apex. The method has since been applied, in a more delicate way, by using lamps specially modified for testing purposes.

This method of testing has always found most favour with the miner; and my recent investigations leave no doubt, in my own own mind, that it may be so applied as to consider-

ably surpass all other testing processes, as regards convenience, and to be in no way inferior to them in delicacy and accuracy.

The gas test, as ordinarily made by the Davy lamp, cannot detect less than about three per cent. of fire-damp in the air. This want of delicacy is partly due to the unsuitablity of the test-flame, which, in order to be non-luminous, must be small, and comparatively low in temperature. It is, in this condition, badly suited to produce flame-caps, but the sensitiveness of the test is also reduced by the flame being surrounded by metallic gauze; the gauze not only obstructs the feeble light emitted by the cap, but also form a bad background against which to observe the cap. For both reasons, therefore, the cap requires to attain some dimensions and luminosity before it can be seen.

MM. Mallard and Le Chatelier, in 1881, considerably improved the ordinary oil safety-lamp, for the purpose of the detection of gas. They used a lamp, in which the flame-cap was viewed through a glass cylinder instead of through wire-gauze, and was seen against a dead black background. The lamp-flame, when reduced, was also screened from the eye by blackened metal screens. By these devices the detection of 0·5 per cent. of gas was rendered possible. The indication, however, was very slight with low per-centages, and the screens had the effect of diminishing the lighting power of the flame when it was turned up to its full size for illuminating purposes. This lamp, however, possessed the great convenience of serving both for illumination and for fairly delicate gas-testing.

MM. Mallard and Le Chatelier, in 1881, strongly recommended the adoption of a hydrogen flame for gas-testing purposes. They found that the flame could detect 0·25 per cent. of gas; and it was only the impossibility of presenting the apparatus in a workable form which prevented the hydrogen flame from being introduced by them.

Pieler, in 1883, also strongly recommended the use of the hydrogen flame, but failed to introduce it into a portable safety-lamp. He only applied it to a stationary testing apparatus in such a way that it has not been sufficiently convenient for general adoption.

Since hydrogen could not be applied to the safety-lamp, Pieler devised a special lamp burning alcohol in a large wire-gauze top, like that of the Davy lamp. The alcohol flame was of considerable size, and was screened from the eye by a metal cone; the top of the cone being the fixed level to which the apex of the flame was adjusted. This Pieler lamp gives flame-caps of extraordinarily large dimensions with low per-centages of gas, but the perception of these caps is much interfered with by the necessity of viewing them through wire-gauze. The indications of this lamp are unreadable when the gas exceeds 2 per cent., and it is therefore necessary to carry an ordinary oil safety-lamp with the Pieler lamp, not only to serve for illuminating purposes, but also as a test for the higher per-centages of gas.

The Pieler lamp, therefore, fails in three important respects as a gas-detector. It is inconvenient, it is a non illuminant, and, in its ordinary form, it is doubtfully safe. The safety of the lamp is said to have been recently secured by modifications introduced by M. Chesneau; but the safety is secured at the cost of extinguishing the lamp in moderately high per-centages of gas, an inconvenience which will be fully understood only by those accustomed to gas-testing.

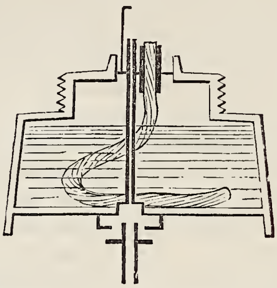
Mr. James Ashworth then modified the Hepplewhite-Gray safety-lamp in construction, and adapted it to burn benzoline. This lamp proved to be an admirable illuminator, and, at the same time, its flame was easily reduced so as to serve as a delicate gas-detector. With care, 0·5 per cent. of gas may be found with this lamp, and 1 per cent. is easily detected and estimated.

The flame is inconveniently sensitive to sudden changes of pressure, to rapid movement, or to rise of temperature; and in its reduced state is liable to extinction from some of these causes.

The only objection which has been raised to the use of the hydrogen flame, arising from the impossibility of introducing the flame into the safety-lamp, has been recently overcome. I described, last year, to the Royal Society, a simple method of introducing the gas into any ordinary safety-lamp, from a store of compressed hydrogen. The gas jet, terminating a small-bore copper tube, which passed from the outside of the lamp through the oil reservoir, was brought up beside the wick tube. Accordingly, when hydrogen was passed through this tube, it was kindled by the lamp-flame. The wick was then drawn down until the oil flame was extinguished, and the hydrogen flame was adjusted to standard size by setting its height to that of a fixed 10 mm. (0·4 inch) wire fixed in the burner of the lamp. This flame was applied for gas-testing. When the bright flame was again required, the wick

was pushed up by the "pricker" until it was kindled by contact with the hydrogen flame. The hydrogen flame was then extinguished, and the lamp became once more an ordinary

Fig 4.



Hydrogen Oil Lamp (Section).

oil safety lamp, suitable for lighting the miner, or for detecting the higher per-centages of gas in the usual way. The way in which this hydrogen-oil-lamp has been adapted for use in testing will be described further on.

The Precise Measurement of Flame-caps.

In order to compare the indications of different safety-lamps, they were successively introduced into the test-chamber, which was filled with air containing known proportions of artificially prepared marsh-gas. The appearance of the flame-cap was then noted, and its height was measured. The cap was not sufficiently bright to illuminate any measuring scale within the lamp. The measurements were accordingly taken by including the ca exactly within the inner edges of a horizonta parallel rule, which was pressed against th window of the test-chamber, and marking thi apparent height upon a paper strip supporte between the rule and the glass. This heigh was then corrected for parallax. Since all th observations were necessarily made in a darl room, the faces of the parallel rule had to b rendered just visible by coating them witl luminous paint.

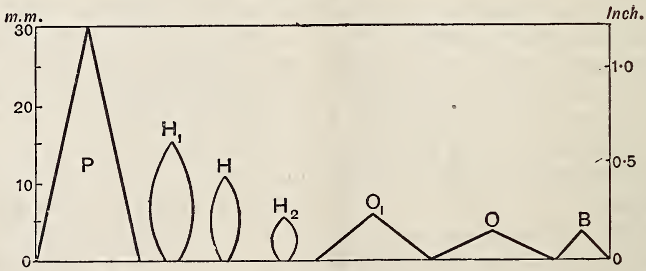
Results of Flame-cap Measurements in Air containing Fire-damp, Coal-gas Water-gas, and Benzoline Vapour.

The lamp-flames used in the experiment had the following approximate dimensions which are here expressed both in millimetre and in inches :—

	Height.		Diameter at broadest part.	
	mm.	inch.	mm.	inch
Hydrogen flame (round)	10	0·4	5	0·2
	15	0·6	6	0·24
	5	0·2	4	0·16
Pieler flame (round, conical).........	30	1·2	13	0·52
Benzoline flame (round, conical)...	3	0·12	7	0·28
Oil flame (flat, slightly conical)...	3	0·12	13	0·52
	6	0·24	13	0·52

They are shown in section, drawn in actua size, in Fig. 5.

Fig. 5.



Testing Flames.
(Actual size.)

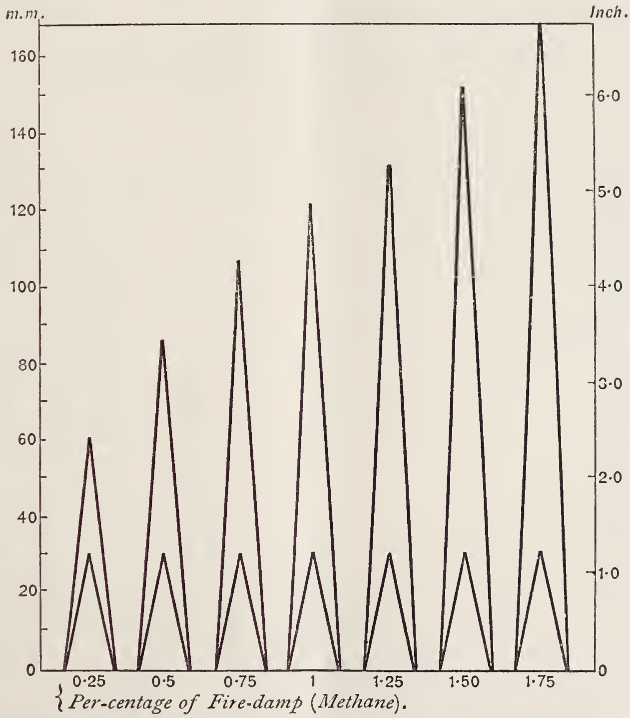
The actual heights of the caps produced over these flames are recorded in millimetres in the Table (p. 313), and the caps are drawn to actual height, except in the case of the Pieler lamp, in Figs. 6, 7, 8, and 9 (pp. 313 *et seq*). The Pieler caps are half the full size only.

In Fig. 10, the series of cap-heights are indi cated to scale by curves, the Pieler being agai half the usual size only, while the benzolin flame-caps are actual size. The indication of the Liveing's apparatus are also inserted i this diagram.

Per-centage of Methane.	Hydrogen flame.			Pieler Alcohol flame.	Ashworth's Benzoline. 3 mm.	Colza-petroleum flat flame.	
	Standard 10 mm.	15 mm. in the Gas.	5 mm. in the Gas.			Small blue 3 mm.	Flame partly luminous, 6 mm.
0·25	17	37	—	30 (?)	—	—	—
0·5	18	42	—	55	7 (?)	—	—
1·0	22	60	—	90	10	—	—
—	—	—	—	140	—	—	—
2·0	31	enters top of lamp	—	reaches top	14	7·5	7·5
3·0	52	—	14·5	—	20	7·5	7·5
4·0		—	22·2	—	25	12·0	24·0
5·0	enters top of lamp	—	35·0	—	30	29·0	41·0
6·0		—	60·0	—	35	67·0	enters top

Multiply millimetres by 0·04 to convert them to inches.

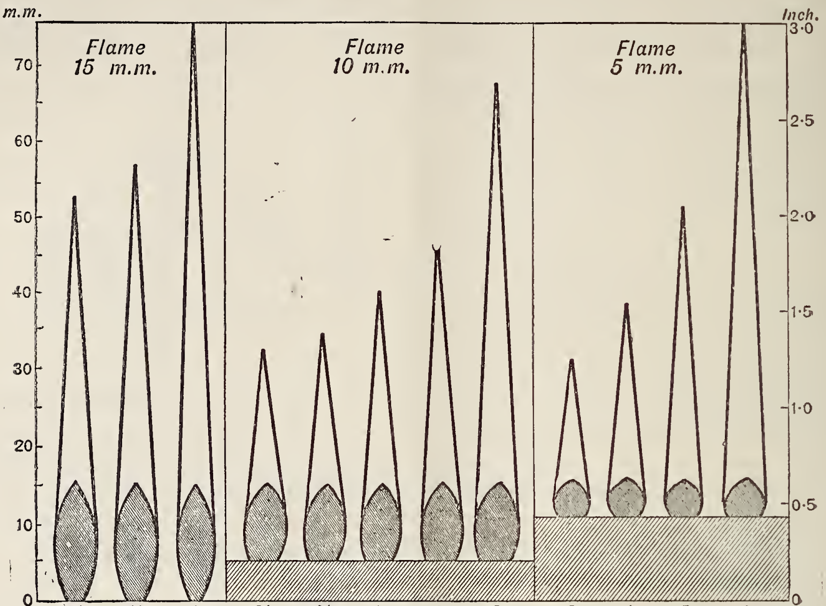
Fig. 6.



Pieler Flame and Caps.
(Half actual size.)

In Fig. 11 (p. 316), the cap-heights furnished by the hydrogen flame, in its three standard sizes, and by the flat oil-flame, are traced to actual size in curves. These are the caps which would be observed in the new hydrogen oil-lamp, when detecting and estimating fire-damp.

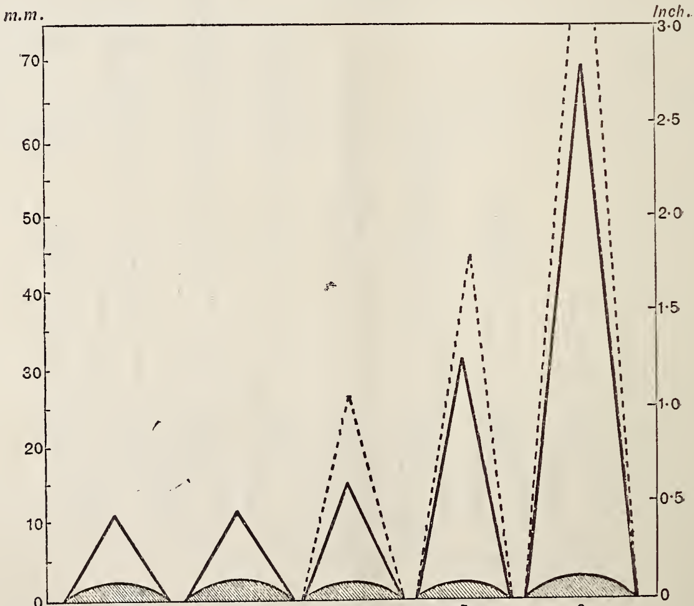
FIG. 7.



{ *Per-centage of Methane (Fire-damp).*

ACTUAL HEIGHTS OF CAPS OVER HYDROGEN FLAMES.

FIG. 8.

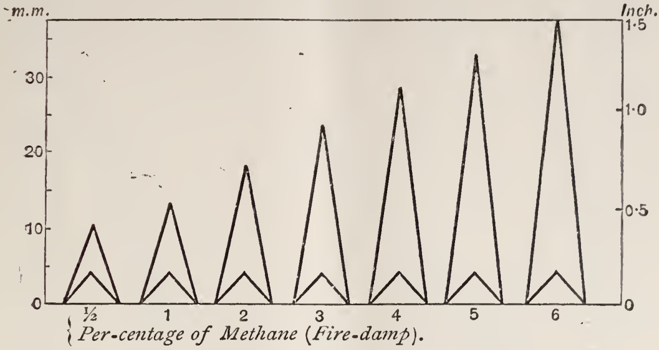


{ *Per-centage of Methane (Fire-damp).*

ACTUAL HEIGHTS OF CAPS OVER COLZA-PETROLEUM FLAME.

The pale blue flame, about 3 m.m. in height, is shown.
The partly luminous flame, giving maximum caps, is not shown, but the cap-heights over it are dotted in.

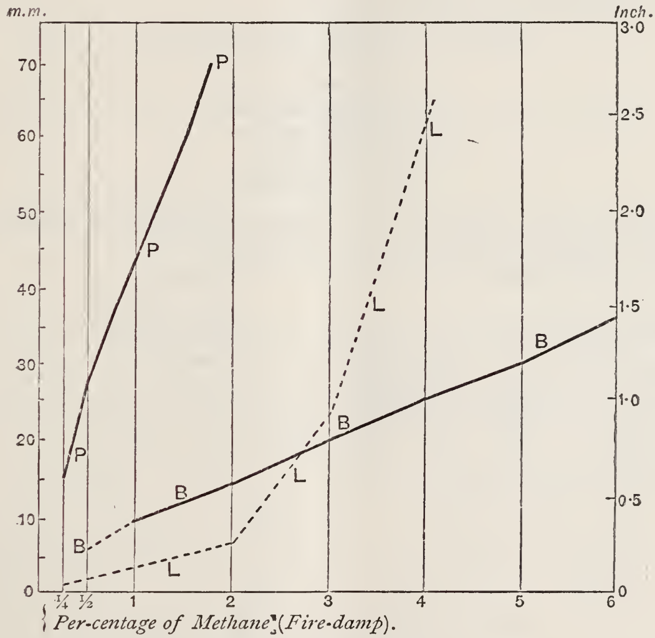
FIG. 9.



FLAME AND CAPS (BENZOLINE).

(Actual Size.)

FIG. 10.



P = Caps over Pieler alcohol flame (one-half height).

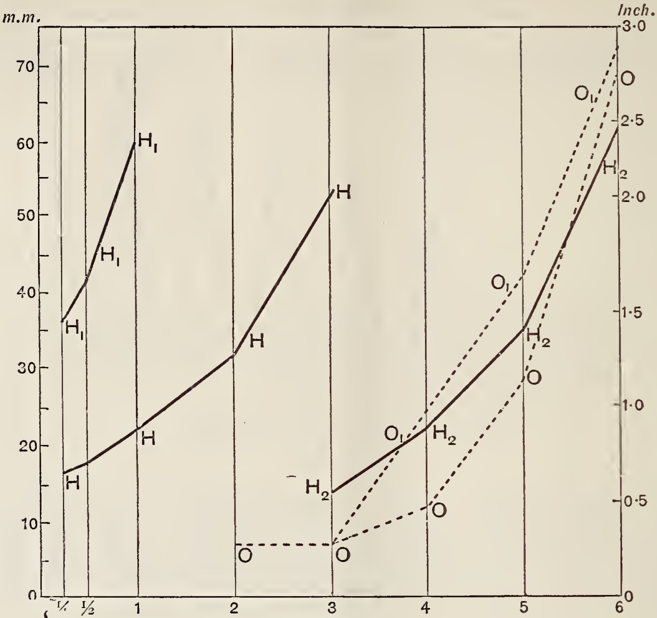
B = Caps over Ashworth benzoline flame (full height).

L = Liveing's electrical indicator relation between light emitted by covered and exposed spirals.

FIRE-DAMP INDICATIONS TO SCALE.

The above measurements were all of them ıken in fire-damp, or its equivalent in rtificially prepared methane, but with the iew of ascertaining the suitability of the new lamp for detecting coal-gas, water-gas, and benzoline vapour in air, cap measurements were taken in air containing these gases and vapour.

FIG. II.



{ *Per-centage of Methane* (*Fire-damp*).

CAP-HEIGHTS WITH HYDROGEN-OIL-LAMP.
(Actual Size.)

H_1 = 15 m.m. hydrogen flame.
H = 10 m.m. hydrogen flame.
H_2 = 5 m.m. hydrogen flame.
O_1 = Maximum oil-flame.
O = Pale blue oil-flame.

Coal-gas.—The flame-caps produced over the hydrogen and oil flames in coal-gas, furnished the following measurements :—

Per-centage of coal-gas.	Cap-height in mm. over hydrogen flame. Standard 10 mm. flame.	Flame raised to 15 mm. in the gas.	Flame reduced to 5 mm. in the gas.	Cap-height in mm. over oil flame reduced until the cap is at maximum.
0·25	15·7	27·6	—	—
0·5	18·4	37·0	—	—
1·0	25·3	60·0	—	—
2·0	40·6	—	—	—
3·0	60·0	—	11·5	15·3
4·0	—	—	30·0	20·0
5·0	—	—	60·0	34·5
6·0	—	—	enters top	65·0 (over)

If these heights are required in inches, they should be multiplied by 0·04.

Water-gas.—The measurements of the flame-caps made in water-gas of average composition are recorded below. The gas gave on analysis the following per-centage composition :—

Hydrogen	49·6
Carbon monoxide	40.8
Carbon dioxide	2·6
Nitrogen	7

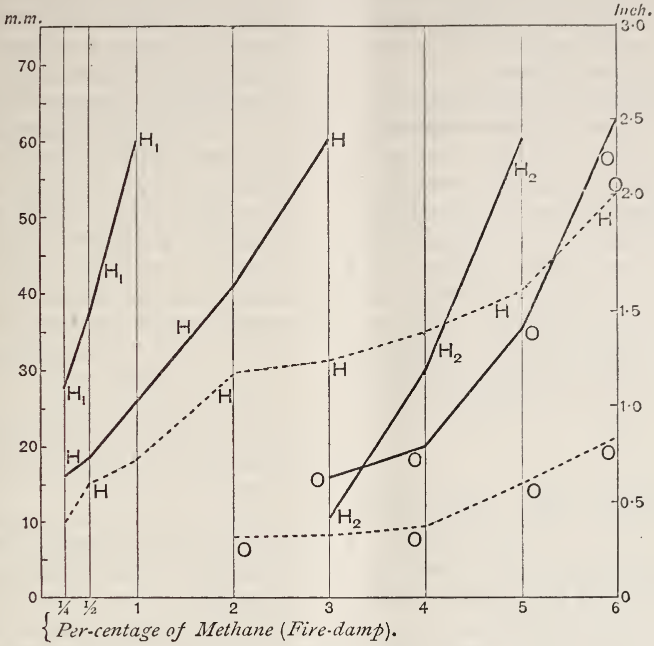
The complete series of flame-cap measurements were as follows :—

Per-centage of water-gas.	Hydrogen flame. 10 mm.	15 mm. in the gas.	5 mm. in the gas.	Colza-petroleum flame, maximum size.
0·25	10	25·3	Nil	Nil
0·5	14·5	33	,,	,,
1·0	17·2	...	,,	,,
2·0	28·7	...	,,	8
3·0	31·4	...	,,	8
4·0	*36	...	,,	9
5·0	*40	...	11	14·5
6·0	*50·6	...	26	20

* In these measurements the tail-like prolongation of the conical cap was not included.

The millimetre measurements are converted into inches when multiplied by 0·04.

FIG. 12.



HEIGHTS OF CAPS OVER HYDROGEN FLAME IN COAL-GAS AND IN WATER-GAS.

The dotted curves are for water-gas.
H = Standard 10 m.m. hydrogen flame.
H_2 = 5 m.m. hydrogen flame.
O = Oil-flame giving maximum cap.
N.B.—The tail or streak above the cap was not measured in for 5 and 6 per cent. of water-gas.

Fig. 12 shows the actual cap-heights, traced s curves, which the new hydrogen-oil-lamp urnishes in air containing known per-centages f coal-gas and of water-gas.

Petroleum Vapour.—The indications of he hydrogen flame have also been examined n air charged with benzoline vapour. Air as "benzolised" by allowing it to bubble hrough a tall column of benzoline. The enzolised air was mixed in known and inreasing proportion with fresh air, and the ixtures were examined as regards their beaviour towards a naked flame. As soon as a on-inflammable mixture was obtained, the ppearance of the "cap" over the hydrogen ame was ascertained in it. The record of esults is given in the next column.

The results of these experiments showed hat the 10 mm. hydrogen flame in the Ashorth safety-lamp will detect a quantity of enzoline vapour in air which is only $\frac{1}{36}$th that f the explosive proportion, and $\frac{1}{20}$th of that

Proportion of Benzolised Air to Air in Mixture.	Behaviour of the Mixture with a Naked Flame.	Height of the "Cap" over the Hydrogen Safety-lamp Flame in the Mixture.
1 : 4	Violently explosive.	
1 : 5 1 : 6 1 : 7	Burns rapidly, and would probably be explosive if fired in large quantity.	
1 : 8	Burns round a flame only.	
1 : 9	Non-inflammable.	
1 : 23	"	52 mm.
1 ; 36	"	43 " 4 " with Ashworth's benzoline flame.
1 : 72	"	31 mm.
1 : 144	"	22 "

which is inflammable when mixed with air. The benzoline flame shows a very small but distinct "cap" when the amount of benzoline vapour is $\frac{1}{9}$th that requisite for the production of an explosive mixture, and $\frac{1}{5}$th that which will yield an inflammable mixture.

The further prosecution of the investigation into the hydrogen-test to petroleum vapour is being undertaken by Mr. Boverton Redwood and myself conjointly, and special apparatus adapted to this object will shortly be described.

In carrying out these very lengthy and tedious measurements, I have received the very efficient and intelligent assistance of W. T. Rigby; who not only has displayed neat manipulation, but in many necessary details of fitting and devising apparatus has shown much ingenuity and fertility of resource.

Conclusions drawn from the above Observations and Measurements.

The general conclusions to be drawn from these measurements, and from working with the different lamps, are the following :—

1. The indications of the Pieler lamp, in air containing fire-damp, begin at 0·25 per cent., but they quickly become too great to be utilised. The thread-like tip extending above the flame for several inches in pure air must not be mistaken for a feeble cap,

   This lamp suffers under the disadvantage that much of the feeble light of the caps is lost by the obstruction of the gauze : the gauze also frequently presents a bright reflecting surface behind the flame, and this renders the observation of the cap impossible. All the other lamps in use, except the Davy, are free from these interferences due to the gauze, and if the back of their glasses are blackened inside, they become well suited for the observation of caps.

2. The Ashworth benzoline lamp begins its indications doubtfully at 0·5 per cent.; the cap thus produced being more distinct, but not greater in height, than the mantle seen in gas-free air.

   But starting with certainty with an indication of 1 per cent., it gives strikingly regular indications up to 6 per cent., and even higher per-centages may be read off in a lamp with a long glass.

3. The standard 10 mm. hydrogen flame gives distinct indications from 0·25 to 3 per cent. ; the cap then becomes too high fo measurement in the lamp, even if provide with a long glass ; but by reducing th flame to 5 mm., cap readings may b taken up 6 per cent. of gas.

   The lower indications may similarly b increased by raising the flame to 15 mm.

4. The oil flame, produced by unmixed colz oil, gives no indications with per-centag below 2. With 1 per cent. of gas th flame from colza, mixed with an equa volume of petroleum (water-white), pro duces an apparent cap. This, thoug somewhat more intense than the natura mantle seen in gas-free air, is only equa to this mantle in dimensions, and migh easily be mistaken for it.

   The oil flame, when it is reduced unt it just loses its luminous tip, howeve gives distinct indications from 3 to 6 pe cent.

   The largest indications are produced b reducing the oil flame in the presenc of the gas, until a cap of maximum size i obtained.

A carefully regulated oil flame may, there fore, conveniently supplement the hydroge flame for the indication of gas varying from to 6 per cent., and in the new hydrogen lam this will be found to be a convenient metho to adopt.

The use of colza alone in the oil-lamp i very inconvenient for gas-testing : the wic quickly chars, and hardens on the top, an cannot then be reduced without danger o extinction ; it can never be obtained satisfac torily in a non-luminous condition. Th admixture with petroleum obviates thes difficulties.

Advantages Gained by the Use of th Hydrogen Flame in Gas-testing.

It will be readily understood that the mai advantages resulting from the use of the hydro gen flame are the following :—

1. The flame is non-luminous, whatever it dimensions may be ; it therefore does no interfere with the perception of the cap.

2. The flame can always be adjusted at onc to standard height, and maintained at tha height sufficiently long for the completio of the test.

   Other testing flames are constantly vary ing in dimensions, and most of them can not be set to standard size at all with an certainty.

   Thus a colza-petroleum flame expose

in air containing a low per-centage of gas, when twice adjusted, gave caps of 8 and of 20 mm. The reduced oil flame often fell so quickly that cap-readings with low per-centages of gas could not be taken at all.

3. The caps produced over the hydrogen flame are larger than those produced by any flame of corresponding size.

4. The size of the hydrogen flame can therefore be so far reduced as to enable it to be used in an ordinary safety-lamp.

   The size of the flame may further be suitably varied in size, so as to increase or decrease the height of the cap. This serves either to increase the delicacy of the test or to extend its range.

5. The hydrogen flame shows no trace of mantle or cap in air free from gas.

   The colza-petroleum and the benzoline flames show pale mantles in gas-free air, which may be easily mistaken for a low per-centage of gas. The Pieler alcohol flame also shows a pale tall thread-like mantle in gas-free air, which might be mistaken for a low per-centage of gas.

6. The standard hydrogen flame burns vigorously, it is of fair size, and therefore cannot be extinguished by accident.

   The reduced flames ordinarily used in testing burn feebly and are readily lost.

7. Hydrogen is supplied practically pure.

   Oil and alcohol are apt to vary much in composition, and therefore to give flames whose indications vary with the sample of liquid which is being burnt.

It has been already shown that the above advantages which are gained by employing the hydrogen flame for the detection and measurement of fire-damp, are also secured in the application of the flame to the detection of other inflammable gases and vapours in air.

Effect of the Ventilation-current and of Coal-dust in the Coal-mine upon Flame-cap Indications.

A long wooden gallery was so fitted that a current of air could be blown along it by a fan at the rate of 300 feet per minute. Provision was also made for introducing coal-gas into this air-current.

Ashworth's lamp showed precisely the same cap-indication in the current of air and gas in movement at the above rate, as in the same mixture when it was at rest. The ventilation current, therefore, does not alter the indications recorded in the still air of the test-chamber.

Experiments were also made to ascertain the effect of introducing fine coal-dust into the air. These showed that amounts of coal dust, ordinarily met with in the coal-mine, produced no disturbance in the indications of the lamp. When the air was as fully charged with coal-dust as possible, however, the flame of the test-lamp became so luminous, that the pale "cap" produced by the presence of gas was invisible. This interference with the test would, however, occur with any form of testing-lamp, and with the Liveing electrical indicator; it is not peculiar to the hydrogen-test.

A New Portable Hydrogen-oil Safety-lamp for Illuminating and Accurate Gas-testing.

The experiments with the hydrogen flame were at first made by introducing the hydrogen from a large cylinder of the compressed gas into the lamp, by the device already described (Fig. 4, p. 312).

In order to render the hydrogen supply portable, the size of the cylinder was much reduced, and the cylinder was carried in a leather case, slung by a strap from the shoulder. It was placed in connection with the lamp by means of a protected flexible tube, provided with a suitable nozzle.

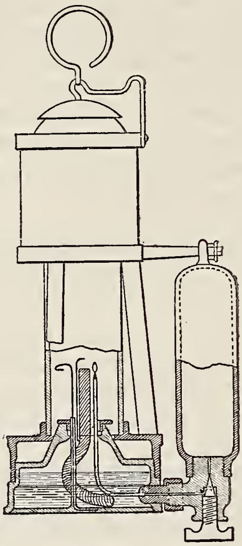
But the maximum degree of portability and convenience has been recently secured, by further largely reducing the size and weight of the hydrogen cylinder. It has been made, at the same time, quickly attachable directly and rigidly, to the lamp, so as to form a convenient handle for supporting the lamp. The cylinder now weighs little over a pound; it measures five inches by one; and several such cylinders may be carried in the pocket without inconvenience. When charged with hydrogen gas from a large store cylinder, under about 100 atmospheres pressure, it furnishes the standard hydrogen flame, burning continuously for about 40 minutes. This small cylinder will receive several hundred charges from a large store cylinder, which starts with a pressure of 120 atmospheres, and is ultimately reduced to about 60.

The cylinder is shown attached to the Ashworth-Hepplewhite-Gray testing lamp, in section, in Fig. 13 (p. 320). The present mode of nection is not here correctly indicated, nor is the valve in the correct position.

But in Figs. 14 and 15 (p. 320) the actual arrangement now adopted is shown. The cylinder is attached and detached from the lamp

instantaneously by a quarter turn. The whole proceeding of passing from the bright flame to the hydrogen flame, making a test, and passing back to the luminous flame, can be effected in thirty seconds.

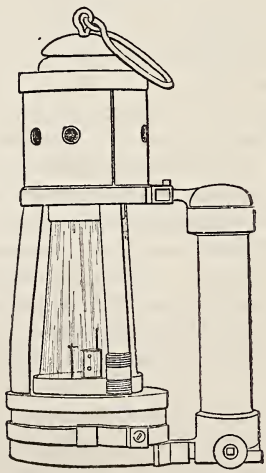
FIG. 13.



PORTABLE HYDROGEN-OIL SAFETY-LAMP, WITH ATTACHED HYDROGEN CYLINDER.
(Section.)

In devising many necessary details in connection with this little cylinder, and in successfully carrying out its production, I have to acknowledge the valuable aid furnished me by

FIG. 14.

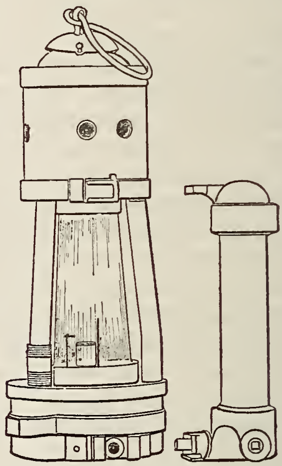


PORTABLE HYDROGEN-OIL SAFETY-LAMP.

Mr. J. M. C. Paton, of the firm of Manlove, Alliott and Co., of Nottingham. Mr. Paton was efficiently backed by his manager, Mr. Lancaster.

The lamp will probably be used as follows:— If the per-centage of gas present is unknown the oil-flame will first be reduced, and a ca looked for over this flame. If the gas amount to 3 per cent., or more, it may be detected an estimated by the flame. If no cap is seen and low per-centages of gas have to be looke for, the hydrogen cylinder is attached, th standard hydrogen flame is obtained in the lamp and the per-centage of gas can be seen and esti mated by this flame, if it is between 0·2 an 3 per cent. As already shown (Fig. 7, p. 314) the hydrogen flame may be used for indicatin and measuring gas varying from 0·25 to 6 pe cent., if its size be suitably varied; but whe it is used with care, the reduced oil flam serves well for the higher per-centages from 3 to 6.

FIG. 15.



PORTABLE HYDROGEN-OIL SAFETY-LAMP, HYDROGEN CYLINDER DETACHED.

The caps are much more readily seen if the interior of the back of the lamp-glass is smoked with a taper, so as to give a dead-black back-ground; and advantage is also gained by making all the reflective metal surfaces in the neighbourhood of the flame non-reflective.

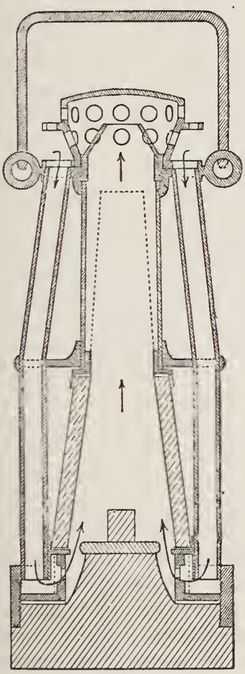
The Ashworth lamp, with a lengthened glass, has been used in the above experiments. It is believed that this is the best form of testing lamp. But the hydrogen cylinder can be readily applied to any form of safety-lamp.

The Ashworth lamp, as is shown by the section in Fig. 16 (p. 321), draws its air supply from the top, and therefore the air close to the roof of the mine can be tested by its means. The air is also at once delivered below the flame,

o that it is unmingled with the products of :ombustion of the flame. The form shown in he Figures 14 and 15 has been specially ested, and proved to be safe in a current of any 'elocity, and containing any proportions of gas.

The new hydrogen-oil-lamp presents the ıdvantage of enabling any ordinary efficient lluminating safety-lamp to be converted into the implest way into a most delicate and efficient ;as-detector. This is effected without perma- ıently adding to its weight, the hydrogen supply ›eing attached only at the spot where delicate ests must be made. If the present attempt to ıtroduce aluminium safety-lamps is success- ıl, the lamp with the hydrogen cylinder at- ached will not exceed in weight the ordinary afety-lamp.

FIG. 16.



ıSHWORTH-HEPPLEWHITE-GRAY SAFETY-LAMP.
(Section.)

The hydrogen-oil-lamp fulfils the primary ›nditions of an efficient testing apparatus; it convenient, it is safe, it is a good illuminant, ıd it combines delicacy with accuracy and ıth a wide range of indications. It has peatedly detected 1 per cent. and 0·5 per nt. of gas in "returns," which were con- lered to contain none.

In the above description of existing gas- sting apparatus, and of the new apparatus oposed by myself, the necessary limits of time and space have compelled me to omit much which should find a place, and to touch too lightly on many points of very great importance and interest. This must be my apology to those who, but for these limitations, would have obtained, what they may have been disappointed in not securing, a full treatment of the very important subject of this paper.

One method of testing has been altogether passed by. Fire-damp is often now tested for by looking for the "spiring" of the full bright flame, turned up to the verge of smoking. I regret the necessity of omitting this method the less, because after carefully testing it, I am convinced that it is far inferior in accuracy and delicacy to the method here fully referred to, of applying the flame-cap test with all necessary precautions. In fact, the test by spiring is only suitable for detecting, and not for measuring gas, when it is present in some quantity. It further fouls the upper gauze with soot, and renders the lamp unsuitable for use.

DISCUSSION.

The CHAIRMAN said there was no subject to which ingenuity, study, and persevering experiment had been applied to a greater extent than to the detection of small quantities of fire-damp in mines. Prof. Clowes, in his lucid description of the history of the subject, had pointed out that it was the one danger which in former days miners thought they had to grapple with. They knew now that that was not so; that coal dust played as important a part in connection with disasters as fire-damp might do, but the fact that small quantities of fire-damp enormously increased the danger from dust still made its detection a most important practical question. When he devoted his attention to the subject some years ago, the Commissioners had a variety of most ingenious devices submitted to them for the detection of fire-damp, one or two of which had been described by Professor Clowes. Liveing's apparatus was most successful, and although a little complicated, it placed in the hands of the miner the means of detecting, without insuperable difficulties, very minute quantities of fire-damp. There were others equally ingenious, such, for example, as eudiometric apparatus for determining rapidly the proportion of fire-damp in the air of the coal pit, and there were others in which it was attempted to determine variations in the density or specific gravity of the air; and others in which testing stations were connected electrically with the mine office above ground; none of these, however, presented anything like the practical features of Liveing's instrument. But this had now undoubtedly been surpassed in simplicity, and, apparently, in certainty, by the patient

investigations of Prof. Clowes. It must be a great boon to the miner, once he overcame his natural prejudice against change, to be supplied, at one and the same time, with an improved safety-lamp and with a means attached to it for detecting, by the mode with which he was already familar, small quantities of fire-damp. It was not necessary, after the lucid explanation which had been given, to point out the advantages resulting from the application of the hydrogen flame; and the lamp produced did certainly seem to be a thoroughly practical testing-lamp. He should be glad to know that not only inspectors of mines, but overmen, and those whose duty it was to test for fire-damp, would give this lamp a thorough trial. They had done so with improved forms of safety-lamp, such as those connected with the application of electricity to the illumination of mine workings, and certainly this particular form of lamp, so little departed from what they were ordinarily accustomed to, that one might hope they would welcome it, and soon familiarise themselves with it. Merely listening to the description for the first time, it was impossible to say whether there were still any defects which had not yet been overcome, but he had been both surprised and delighted at the degree of perfection which had already been reached.

Prof. Le Neve Foster, F.R.S., said he wished first to refer to some figures to which attention had been called in the paper, showing the great reduction in the mortality from explosions in coal mines, and to point out that the comparison was really much more favourable than appeared by the Table, because the amount of coal got, and the number of persons employed, had very notably increased during the last forty years. Prof. Clowes had pointed out that his lamp would be useful not only in testing for fire-damp in mines, but also for ascertaining the presence of petroleum vapour in the tanks of steamers; and it might be well to remark that there were also mines in which volatile hydrocarbons were present. You find them in the terrible fiery mines of ozokerite, in Galicia, where crude petroleum may be seen running about in the levels; and he felt convinced, from his own observation, that not only was the air charged with fire-damp, but also with these volatile hydrocarbons, rendering the workings exceedingly dangerous. He had followed the development of the testing chamber, since it was introduced by Professor Clowes at the British Association meeting at Cardiff, when he was much struck by its utility, especially for the purpose of testing lamps, and showing students and miners the "caps" produced by different mixtures. He obtained one for the Royal School of Mines, where it was regularly used by the students. There was no doubt, after what had been said by Professor Clowes and the Chairman, that there was a necessity for an improved method of testing. The foe was invisible, and, at present, though you had the means of ascertaining its presence when it reached 2 per cent., or a little over, the ordin[ary] means gave no indication whatever below t[hat] amount. If the soldier welcomed a better fiel[d] glass, by which he could detect the enemy at a grea[ter] distance, and if the medical man was grateful [for] a better microscope, which enabled him to det[ect] the minute organisms which were the cause of m[any] diseases, so ought the miner to welcome this n[ew] lamp. That afternoon he had the opportunity [of] seeing some tests made with it in the testin[g] chamber, when the atmosphere within contained [] per cent. of fire-damp, and the cap on t[he] hydrogen flame was thoroughly apparent. O[ne] point which occurred to him was the question of t[he] possibility of the gas rushing from the reservoir in[to] the chamber, and producing an explosive mixtu[re] which might burst the lamp and communicate t[he] explosion to the outside; but he found there wa[s a] delicate valve, worked with a key, which seemed [to] render any such accident impossible. He only [re]gretted there were not more mining men preser[nt], but there was another meeting elsewhere th[at] evening, which had to a certain extent drained t[he] audience. This was another instance of science fr[om] outside coming to the aid of the miner, who was t[oo] apt to move in a groove.

Mr. Boverton Redwood said his attention w[as] directed, some 18 months ago, to the results whi[ch] Professor Clowes had obtained in the application [of] the hydrogen-flame in the safety lamp to the dete[c]tion of small per-centages of fire-damp, and bei[ng] then engaged in experiments connected with acc[i]dents which had occurred in the transport of crude petr[o]leum, one object being to ascertain the best means [of] detecting small quantities of volatile hydro-carbons [in] the atmosphere of tanks, &c., it naturally occurred [to] him that a method which had afforded such sati[s]factory results in the case of fire-damp might be appl[ic]able. He accordingly suggested the investigation [of] this branch of the subject to Professor Clowes, and t[he] promising results obtained were communicated to t[he] meeting of the British Association at Cardiff. Sin[ce] then he had been working at the subject in conjuncti[on] with Professor Clowes. There were certain i[n]stances in which it would be undesirable, in h[is] judgment, to employ these lamps, and he h[ad] met with cases in which he should refuse to se[nd] a man into a tank, or enclosed space, for the purpo[se] of making such a test. In cases of that kind, [a] sample of the atmosphere should be collected, a[nd] tested subsequently, and that introduced the questi[on] whether these lamps would be useful for testing t[he] air so obtained. Probably they might be used, b[ut] under some circumstances, perhaps, a modified fo[rm] might be used with greater advantage as a seco[nd] test. For such purposes, the lamp need [not] be to the same extent portable, and it ne[ed] not be a safety-lamp, except with regard [to] the vessel in which the possible explosive samp[le] of air was contained. The presence of petrole[um]

pour in mines was a very important matter. Some ne ago he had the opportunity of visiting the Ozo-:rite mines, and could confirm what Professor Foster id said, that the inflammable nature of the air was rgely due to the presence of volatile hydrocarbons om petroleum. There were also coal mines in this untry where petroleum springs occurred; and the l had been met with in the shale mines in Scot-nd. In the discharge of his duties, for a long time st, he had had to make use of the alcohol flame detecting small quantities of petroleum vapour, d had also worked with Ashworth's benzoline np. He could, therefore, form an opinion as to e relative merits of the various flames, and d pleasure in confirming most fully the state-ents made as to the superiority of the hydrogen me. Personally he had never experienced any fficulty in detecting the caps, but it was conceivable at in the use of the hydrogen flame for testing board ship, where it might be difficult to secure fficient darkness, it might be desirable to have me means of increasing the luminosity of the cap. rhaps this might be effected by an increase of the nospheric pressure under which the combustion s taking place. Whether that object might not be feated by an equal increase in the luminosity of e flame itself, he was not yet in a position to say. ofessor Clowes and he were hopeful that they uld be able to produce a series of instruments ich would be adapted to the various conditions evailing, and which would give results as satis-tory as those obtained with the lamp now brought der notice. He looked forward to the general adop-n of the hydrogen flame for cooling, with the vitable result of diminishing the risk of occurrence a very deplorable class of accidents.

Mr. FLETCHER congratulated Professor Clowes on : way in which he had worked out this subject, until obtained so successful a result. With regard to : testing of an atmosphere containing both in-mmable gases and dust, he supposed that the st might have been filtered out by a layer of cotton ol.

Mr. OLIVER WILLIAMS asked if Liveing's in-ator was affected by the presence of dust.

The CHAIRMAN said it might be to some slight ent.

Mr. THWAITE wished to add his tribute to the ngratulations already expressed. His experience connection with petroleum steamers was very nited, but immediately after the explosion on the *triana*, when many lives were lost, he went on ard, and the appearances indicated that the men the hold—the vessel having been cleared of petro-m—were scorched to death. He was quite con-ced that if a lamp of this character had been d before the men entered the tank, there would : have been that deplorable accident.

The CHAIRMAN said no questions had been raised calling on Professor Clowes for a reply, and it only remained for him, therefore, to propose a vote of thanks to him for his interesting communication, and to express the hope that the results he had obtained might speedily bear practical fruit in the hands of the miner, as well as in other directions. Mr. Redwood and the last speaker had emphasised the importance of applying this method to the testing of the atmosphere of petroleum-laden vessels; and he might also point out, that in connection with the large coal bunkers of ships of war, and in coal laden ships, it was of great importance to be able to test the air in the bunkers. Accidents of a deplorable nature had frequently arisen through the accumulation of an explosive atmosphere in its coal bunkers, and leakage thence to other parts of the vessel, where it came in contact with a naked flame; or even through the introduction of a naked light into the bunker when the vessel was coaling. Liveing's apparatus had been applied to such cases with success; but Prof. Clowes's had the advantage of great simplicity, and no doubt it would be applied to a great extent in that direction.

The vote of thanks was carried unanimously.

Miscellaneous.

CHICAGO EXHIBITION.

REGULATIONS GOVERNING AWARDS.

Rule 1. Conformably to the determination of the Commission, "awards shall be granted upon specific points of excellence or advancement formulated in words by a board of judges or examiners, who shall be competent experts."

Rule 2. *Board of Judges.*—This board of judges, which shall be composed, so far as practicable, of competent experts, shall be divided into thirteen committees, one of which shall be assigned to each of the thirteen great departments of the Exposition, as recognised by the classification adopted by the World's Columbian Commission. The number of judges composing this board, and each committee thereof, shall hereafter be determined. There shall be one or more women judges upon all committees authorised to award prizes for exhibits which may be produced in whole or in part by female labour; and the number of women upon such committee shall be hereafter determined according to the method heretofore prescribed by said Commission, after conference with the President of the Board of Lady Managers and the Awards Committee thereof.

Rule 3. *Individual Judges.*—The individual members of the said thirteen committees shall be, so far as possible, competent experts, and shall perform such duties and examine such exhibits as shall be assigned them by the Executive Committee on

Awards. There shall be a foreign representation upon each one of these thirteen committees, and the number of foreign judges will be fixed when the character and extent of the participation of the various foreign nations shall have been ascertained.

Rule 4. Each committee shall, at the call of the Executive Committee on Awards, organise, by the election of a president, vice-president, and secretary, and shall keep a record of all returns and reports by the individual judges, as hereinafter provided for.

Rule 5. *Duties of Judges.*—It shall be the duty of each individual judge to make a report in writing, over his signature, of the result of the examination of each exhibit primarily examined by him, as each examination shall have been completed; and as to every exhibit so examined which he shall deem worthy of an award, he shall formulate in words the specific points of excellence or advancement disclosed thereby, and which, in his opinion, render it worthy of an award. Every report shall be submitted, as soon as possible, to the committee of which such judge is a member, for a finding in the premises; and in every case where, by the vote of the majority of such committee, it is determined that an exhibit is worthy of receiving an award, said committee shall forthwith formulate, in written words, the specific points of excellence or advancement which, in his opinion, warrant the award, and transmit the same, certified by its President, or Vice-President, and Secretary, to the Executive Committee on Awards. And in case the finding of the committee shall differ from the conclusion of the individual judge making the preliminary examination, either as to its being worthy of an award or as to the character of the points of excellence or advancement it possesses, it shall be so distinctly stated in the report of said committee. In every case where the finding of the departmental committee coincides with the conclusion of the individual judge, the said committee shall transmit, with such finding, the report of such individual judge to the Executive Committee on Awards; and in those cases, where the finding of the departmental committee does not coincide with the conclusion of the individual judge, then the finding in each case shall be accompanied by the written report of one of its members who shall have examined the exhibit, formulating therein in words the specific points of excellence or advancement possessed by such exhibit.

Rule 7. *Notice to Foreign Nations.*—This Executive Committee on Awards shall communicate, through the Director-General of the World's Columbian Exposition, with the foreign governments which have appointed commissions to represent them at the World's Columbian Exposition, or with the said commissions directly, stating the character of the awards, the ground upon which they are to be granted, and the requirement that all judges shall be, so far as practicable, competent experts. And the foreign governments shall be invited to recommen[d], previous to March 1, 1893, experts in the various de[-]partments, and from those named the Executive Com[-]mitte on Awards may make selections. The especi[al] attention of foreign governments shall be called to th[e] fact that there will be but one class or kind of medal which will be made of bronze and be works of a[rt], and be accompanied by parchment diplomas, on whic[h] shall be formulated the specific points of excellenc[e] presented by the exhibit receiving the award. Notic[e] shall be given to all exhibitors, whether domestic o[r] foreign, that the medals and diplomas to be awarde[d] are by authority of the Congress of the United State[s] and are prepared by the Secretary of the Unite[d] States Treasury.

Rule 8.—Should any exhibitor, domestic or foreig[n] become a judge under these rules, his or her exhib[it] shall be excluded from examination for award, but th[e] Executive Committee on Awards may cause suc[h] exhibit to be examined, and a report thereon made t[o] complete the history of the Exposition.

Rule 9. *Right to Examine Exhibits.*—Any ex[-]hibitor may have his exhibit exempt from examina[-]tion for award by notifying the Executive Committe[e] on Awards; otherwise the Executive Committee o[n] Awards shall have the right, through its regular[ly] appointed judges, to examine every exhibit, domest[ic] or foreign, whether presented by an individual, asso[-]ciation of individuals, institution, Government, o[r] department thereof.

Rule 10. *Date of Commencing Work.*—The wo[rk] of the judges shall commence not later than th[e] 1st day of June, 1893, and shall progress uninte[r-]ruptedly until the completion of the work assigne[d] them, except in the Department of Live Stock and [in] those departments where the nature of the exhibi[t] requires renewal from time to time during the Ex[-]position.

Rule 11.—Upon the completion of the work of th[e] judges, the results thereof shall be presented by th[e] Executive Committee to the full Committee o[n] Awards, which committee shall in turn report to th[e] World's Columbian Commission, or, in its absenc[e] to the Board of Reference and Control, by who[m] the formal promulgation of the awards and th[e] distribution of medals and diplomas shall be ma[de] with appropriate ceremonies.

Rule 12.—In addition to the reports by the ind[i-]vidual judges of the various exhibits, each of th[e] thirteen committees shall present a comprehensi[ve] report, signed by the President and Secretary, em[-]bodying the principal educational and interestin[g] features of the groups and classes composing th[e] department, accompanied by a list of exhibitors wh[o] have received awards, with the reports of the ind[i-]vidual judges giving the reasons and consideratio[ns] therefore; and this report shall be delivered to th[e] Director-General to be included in, and to form pa[rt] of, the history of the Exposition; but this sha[ll]

ot be so construed as to prevent or interfere ith the duty expected of each of the department hiefs to prepare and submit, as part of the official istory of the Exposition, a complete and compreensive report of the work of his department.

Rule 13.—In the performance of the duties inrusted to the Executive Committee on Awards, any nember thereof shall have the right to be present at he deliberations of the committees herein provided or, and in all matters of review or other complication he said Executive Committee shall have the right to vail itself of the aid and service of any member or iembers of the Committee on Awards, and as well f the advice and assistance of any competent agency whose aid ought, in its best judgment, to be invoked.

GEORGE R. DAVIS,

Director General.

Administration Building, Exposition Grounds,
Chicago, January 16 1893.

ITICULTURE AT THE CAPE OF GOOD HOPE.

From a report recently issued by the Department f Agriculture of the Cape Colony, it appears that ie pressing of wine at the Cape generally begins bout the end of February, and continues during the hole of the month of March, the exact period varyg with the kind of product which is desired. If ght table wines are wanted, the gathering comiences early; if, on the contrary, sweet wines, like onstantia, are desired, the bunches are left almost dry up as they hang. Three leading descriptions f wine are made in the colony—(1) Sweet wines, nder the general name of "Constantia," (2) dry hite wine, and (3) table wines. The sweet wines e commonly made from the white and red Frongnac and the red Haanepoot. For this purpose ie grapes are allowed to become very ripe, almost to esiccation. The material is then placed in the vat id moistened with must from the same sort of grape ready undergoing fermentation, and the mass is left r two days. It is then drawn off into vats, where ie fermentation continues slowly. It is estimated iat to produce a leaguer of this wine, the quantity grapes corresponding to five leaguers of ordinary ine must be taken. The price accordingly is roportionate, and these wines ultimately become quisite and inimitable. The best-known *cru* that of "Constantia," a farm started in 99 by Governor Van der Steel, and situate the foot of Table Mountain. The second scription of wine includes white wines belonging the large categories of Madeira and South Spanish ines, particularly of the sherries, Alecantes, and white ports. The chief sort of grapes used to produce them are the Haanepoot and Muscadel. When the wines have been well made, they are excellent, and certainly may compete with the best of their kind in Madeira and Spanish sorts. The best red table wine at the Cape is that which is obtained from the *grosse syrah*, a vine known in the colony under the name of "Hermitage." This product resembles the wines of Southern France and Algeria; but its quality depends greatly upon the farm on which it is produced, the skill of the cultivator, and the mode of fabrication. Most frequently, the grapes are left to ripen too long, the fermentation too long continued, and the must lies on the husks too long, even as much as fifteen or twenty days. In addition, the fermentation is made in open vats, covered with nothing but hides, and with too little attention to cleanliness. For some years back, attempts have been made at Constantia to make wines of the Bordeaux and Burgundy type, with the Cabernet and Pineau grapes. The Pontac is another description, which is made from the grapes of that name. It is a wine of very deep colour, and heavily loaded with tannin, which gives it an astringent and peculiar flavour. With Haanepoot and Red Frontignan, port wines of strong bouquet are made. Finally, white table wines, of a comparatively light character, are made with Riesling, Steen, Steen grape and Spengler, and these appear in the market as "still hock" or "white hermitage." Despite the progress recently made in this manufacture, they are, it is said, still far too alcoholic and too heating for the climate. Two sorts of brandy are made at the Cape. First a brandy from the husks, and of this the return is considerable. One leaguer of brandy at 65° is expected from ten leaguers of wine, and in some cases is obtained in the proportion of 1 to 5. Secondly, brandy obtained by distillation of spoiled or even of good wines, in places with imperfect means of communication, with no market near, or where the transport would be too costly. The apparatus used in distilling is of the most primitive kind, and is reduced to the barest essential elements, every farm having its own. The brandy is of good quality when well made, and closely resembles the French brandy made at Armagnac. Grapes are chiefly prepared as follows:—The finest bunches are cut when quite ripe, they are then dipped in a hot ley of wood ashes, obtained by burning certain bushes. The immersion, which lasts only a few minutes, is intended to harden the skin of the grape, to coagulate the albumen, and to facilitate desiccation. The bunches, when withdrawn from the cauldron, are set up in the open air and spread on calico frames or simply on straw. Women are employed to turn them several times during the day, and to withdraw them as they become sufficiently dried. In conclusion the report states that the viticulture of the Cape seems to have a great future before it, and to attain it the viticulturists have only to improve their modes of cultivation and of making their wines.

BUTTER-MAKING IN FINISTERRE.

At Morlaix, the butter industry is very important, the total annual export amounting in value to 13,000,000 francs. The United States Consul at Nantes says that six houses are engaged in this industry, and they export butter to England, Norway, and Sweden, the East and West Indies, and to South America. The butter for these markets is not manufactured at Morlaix, but is purchased, in small or large quantities, from farmers all over the country, and sent to Morlaix in large willow baskets, containing about 200 lbs. each. All quantities of butter are accepted. At the manufactories, the butter is emptied into large kneading troughs, where it is graded, and then worked over by hand with very large wooden spoons, made for that special purpose. It is next forced through the fluted rollers of a kneading mill by steam-power. These two operations serve to extract whatever milk or water remains in the butter, a very important point for its preservation. Up to this point, all the butter for exportation is worked in the same manner. The best grade, which is shipped to England, Norway, and Sweden, and to the large cities of France, is, after being washed (which is done only when necessity requires, as it is not advantageous for the preservation of the butter), worked on a circular table with fluted rollers. Steam-power is employed to move the rollers. On the same table the salting and colouring are done during the manipulation. This grade of butter receives from 5 to 6 per cent. of salt, aud the colour given is of a light gold. The butter is packed in earthen jars containing from 10 to 60 pounds, according to size; white tissue paper is put over the butter, and salt spread over the paper; the jar is covered with strong canvas, and hoops of straw put round it to prevent breakage; it is then ready for shipment. This butter is said to be excellent for kitchen use, and for making pastry, and will keep well for from six to eight months. The butter exported to South America, more especially to Brazil, and to the East and West Indies, is of an inferior grade. After passing through the kneading mill it is worked, salted, and coloured on the same table, and with the same rollers, as the pastry butter, with this difference:—(1) It is not washed; (2) it is salted at the rate of from 12 to 13 per cent.; and (3) it is highly coloured. The butter sent to Brazil is of a better quality than that sent to Guadeloupe and the other West India islands. It is of a deep orange colour, while the poorer quality is coloured a shade of red, resembling very nearly the colour of a ripe tomato, and is sold to the negroes, who prefer it on account of its red colour. This butter is packed in kegs made of American black oak, holding about 75 pounds. Strong white tissue paper is put over the butter, instead of cloth, and a layer of salt is spread over the paper, the bottom of the keg being similarly arranged before packing the butter. The butter so prepared keeps well for from ten to twelve months. In all cases the matter used in colouring i[s] a vegetable substance named *roucou*, imported, in th[e] form of paste, from Cayenne and the West Indies and each manufacturer prepares it as he chooses This is generally done by mixing the paste with oliv[e] oil, and adding saffron in sufficient quantity to obtai[n] the right colour. In all cases the salt used is pulverised sea salt, the use of which is said to b[e] important for the preservation of butter.

Correspondence.

THE CURRENCY PROBLEM.

I do not wish to deal further with this than to protest against such a subject being made a matter of promiscuous discussion in a scientific society, as no subject of natural science would be. Several men of ability occupy pages of our *Journal* with their observations.

The result is of no utility, because it is impossible thus to deal with a matter of varied aspects and great complexity by taking up some casual feature.

They have, however, been dealt with *secundum artem*, with columns of figures, averages, tables, index numbers, and the whole appliances of statistical fallacies, which are so generally accepted as scientific facts and certainties of the numerical method.

At p. 231 is a Table of coinage of gold and silver in France from 1806 to 1875, which gives £323,000,000, total, of gold coined, and £217,000,000 of silver. If the later figures are taken, from 1846 to 1875, the ratios are quite different. £55,000,000 average, or £275,000,000 total, of gold; and £12,000,000 average, or £60,000,000 total, silver.

The figures, too, are put forward without any reference to the circumstances under which the coinages took place. Napoleon coined up all the bullion he could get hold of. The restored Bourbons did the same to displace the Napoleon coinage. Louis Phillippe's dynasty re-coined and displaced Bourbon coins. After him came Napoleon III.; and now the Republic. Many of these coins were used for export to foreign countries, where a 20-franc or a 5-franc piece is an acceptable coin.

As to index numbers, Mr. J. Biddulph Martin has well enough dealt with them, and he says they ought to be a weighted average (p. 236). He also referred to the many causes in operation to be taken into account, as facilities for transport, and the enormous improvements in manufacture, whereby many articles are produced at less than half their cost a few years ago. This notably applies to silver itself, an article which, according to some of the speakers, is grievously persecuted and depreciated by gold and the monometallists; whereas silver is chiefly depreciated by silver itself, and the present cost of production cannot be suited to its old standard.

HYDE CLARKE.

General Notes.

Kopp Memorial Lecture.—An extra meeting ˙ the Chemical Society will be held on Monday, ›th inst., the anniversary of the death of Hermann :opp, when a lecture will be delivered by Prof. . E. Thorpe, F.R.S.; the Right Hon. Lord ayfair, F.R.S., will take the chair.

Imported Dairy Products.—A marked feature the British imports is the steady progress of dairy roducts, which increase in amount year by year, and r which was paid last year, according to the declared alue, over £22,000,000 sterling. Of butter, we ceived 2,183,000 cwt., chiefly from Denmark and rance, and of imitation butter, or margarine, ,305,350 cwt., principally from Holland, where it largely prepared with animal fat and cotton-ed oil. Nearly £3,750,000 sterling was paid for is butterine, or more than one-fourth the sum aid for genuine butter. Of cheese, we im-orted 2,232,814 cwt., half of which came from e Dominion of Canada. Of condensed, or pre-rved milk, we received 500,000 cwt., for which we aid £930,288. The import of eggs increases enor-ously, and exceeded last year 11,000,000 "great ndred," valued at nearly £3,800,000.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock :—

February 22.—Mr. T. Mackay, "Old Age ensions." The Hon. Sir Charles W. Fremantle, .C.B., will preside.

Papers for subsequent meetings, the dates f which are not yet fixed :—

"Transatlantic Steamships." By Prof. Francis lgar, LL.D.

"Tele-photography." By Thomas R. Dall-ieyer.

"The Optical Correction of Photographic Per-pective." By H. Van der Weyde.

"Music in Elementary Schools." By W. G. IcNaught.

"Technical Education: its Progress and Pros-ects." By Sir Philip Magnus.

"The Construction of Locks and Keys." By Iarry W. Chubb.

Indian Section.

Thursday afternoons, at 4.30 p.m. :—

March 9.—Jervoise Athelstane Baines, I.C.S. (Bombay), "Caste and Occupation at the last Census of India." The Lord Reay, G.C.S.I., G.C.I.E., will preside.

April 6.—The Hon. Sir Edward N. Coventry Braddon, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisa-tion."

April 27.—Sir Juland Danvers, K.C.S.I., "Indian Manufactures." Sir Alexander Wilson, formerly President of the Bengal Chamber of Com-merce, will preside.

May 11.—Sir Raymond West, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results."

Foreign and Colonial Section.

Tuesday evenings at Eight o'clock :—

February 28. — Sir Edward Braddon, K.C.M.G., "Russia as a Field for Tourists." Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., will preside.

March 21.—Cecil Fane, "Newfoundland." Sir Charles Tupper, Bart., G.C.M.G., will preside.

April 18.—H. A. McPherson, "The Philippine Islands."

May 2.—E. Delmar Morgan, "Russian In-dustrial Art."

May 18.—W. B. Percival, Agent-General for New Zealand, "New Zealand."

Applied Art Section.

Tuesday evenings, at Eight o'clock :—

February 21.—T. R. Spence, "Wall-papers and Stencilling." Lewis F. Day will preside.

April 11.—Prof. Paul Schulze, "History and Development of Pattern Designing in Textiles." Thomas Wardle will preside.

May 9. — Prof. W. M. Flinders Petrie, "Primitive Art in Egypt." Edward J. Poynter, R.A., will preside.

May 30.—James Dallas, "Devonshire Pottery."

*** The meeting originally announced for March 14 will not be held, but will be replaced by an additional meeting in May.

Cantor Lectures.

Monday evenings, at Eight o'clock :—

Prof. J. A. Fleming, M.A., D.Sc., F.R.S., "The Practical Measurement of Alternating Electric Currents." Four Lectures.

LECTURE IV.—FEBRUARY 20.—*The Measurement of Alternating Current Energy.* — Alternating current ergmeters—Meters for energy : Shallenberger, Thomson, Brillé, Frazer, Ferranti — Meters for quantity : Mengarini, Richard, Frazer—Watt-hour meters or high tension primary circuits—Methods of measuring total output of alternating current stations —Efficiency of supply—Conclusion.

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Three Lectures. March 6, 13, 20.

LEWIS FOREMAN DAY, "Some Masters of Ornament." Four Lectures. April 10, 17, 24; May 1.

C. HARRISON TOWNSEND, F.R.I.B.A., "The History and Practice of Mosaics." Two Lectures. May 8, 15.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 20...SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. J. A. Fleming, "The Practical Measurement of Alternating Electric Currents." (Lecture IV.)
Cleveland Institute of Engineers, Middlesbrough, 7½ p.m.
Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. G. M. Freeman, "The Arbitration Act, 1889."
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Mr. J. W. Slater, "Life and the Physical Forces."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. C. Dickens, "Three Views of the Pathos of Charles Dickens."
Chemical, Burlington-house, W., 8 p.m. Extra Meeting. Prof. T. E. Thorpe, "Kopp Memorial Lecture."

TUESDAY, FEB. 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. T. R. Spence, "Wall Papers and Stencilling."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Functions of the Cerebellum, and the Elementary Principles of Psycho-Physiology."
Civil Engineers, 25, Great George-st., S.W., 8 p.m. Discussion on Dr. Edward Hopkinson's paper, "Electrical Railways."
Statistical, School of Mines, Jermyn-street, S.W., 7½ p.m. Dr. Francis Warner, "Observations on Mental and Physical Conditions of Children."
Pathological, 20, Hanover-square, W., 8½ p.m.
Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Lieut. Boyle T. Somerville, "Ethnological Notes on the New Hebrides." 2. Mr. E. H. Man, "Nicobar Pottery."
Sanitary Institute, Parkes' Museum, Margaret-street, W., 8 p.m. Prof. W. H. Corfield, "Sanitary Appliances."

WEDNESDAY, FEB. 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. T. Mackay, 'Old Age Pensions."
Geological, Burlington-house, W., 8 p.m.
Entomological, 11, Chandos-street, W., 7 p.m. Dr. T. A. Chapman, "Some neglected points the Structure of the Pupa of Heterocerous Lep doptera, and their probable value in Classification 2. Mr. Charles J. Gahan, "Notes on the Long cornia of Australia and Tasmania (Part I) inclu ing a List of the Species collected by Mr. J. Walker, and Descriptions of New Forms." Dr. Frederick A. Dixey, "The Phylogenetic Si nificance of the Variations produced by Differenc of Temperature on *Vanessa atalanta*."
Royal Society of Literature, 20, Hanover-square, W 8 p.m.
Geological, Burlington-house, W., 8 p.m. 1. M Edward Wethered, "The Microscopic Structu of the Wenlock Limestone." 2. Dr. Wheelt Hind, "The Affinities (1) of *Anthracoptera*, (of *Anthracomya*." 3. Lieutenant G. C. Frederic R.N., "Geological Remarks on certain Islands the New Hebrides."

THURSDAY, FEB. 23..Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Camera Club, Charing cross-road, W.C., 8 p.m Mr. A. Pringle, "The Routine of Gelatine Emu sion Making."
London Institution, Finsbury-circus, E.C., 6 p.m Mr. Donald Mackenzie, "The Present State the Morocco Empire."
Royal Institution, Albemarle-street, W., 8 p.m Prof. Patrick Geddes, "The Factors of Organ Evolution."
Electrical Engineers, 25, Great George-street, S.W 8 p.m. Mr. W. M. Mordey, "Note on Testin Alternators."

FRIDAY, FEB. 24...United Service Institute, Whitehall Yar 3 p.m. Captain Alfred Hutton, "Our Sword manship."
Royal Institution, Albemarle-street, W., 8 p.m Weekly Meeting, 9 p.m. Dr. E. Hopkinso "Electrical Railways."
Civil Engineers, 25, Great George-street S.W 7½ p.m. (Students' Meeting.) Mr. R. R. Hansfor Worth, "The Methods Usually Adopted in Devo and Cornwall for Dressing China-Clay and Ti Ore."
Sanitary Institute, Parkes' Museum, Margaret-stree W., 8 p.m. Mr. J. Wright Clarke, "Details Plumbers' Work."
Clinical, 20, Hanover-square, W., 8½ p.m.
Physical, Science Schools, South Kensington, S.W 5 p.m. 1. Prof. J. D. Everett, "A Hand Focometer." 2. Dr. C. V. Burton, "Plain an Spherical Sound Waves." 3. Mr. G. H. Brya "Motion of a Perforated Solid in a Fluid."

SATURDAY, FEB. 25...Botanic, Inner Circle, Regent's-par N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m Lord Rayleigh, "Sound Vibrations."

CORRECTION.—Mr. J. S. Vaughan writes that th name of the inventor who took out a patent for th use of salts of manganese, in the making of s called "drying oils," was "Christopher Binks," an not "Vince," as printed on p. 289, col. 1.

The Telegraphic Address of the Society of Arts and of the Royal Commission for the Chicag Exhibition, is "Praxiteles, London."

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FRIDAY, FEBRUARY 24, 1893.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, 20th inst., Prof. J. A. LEMING, M.A., D.Sc., F.R.S., delivered the urth and last lecture of his course on "The ractical Measurement of Alternating Electric urrents."

On the motion of the CHAIRMAN (Mr. W. . Preece, F.R.S.), a vote of thanks to the cturer for his valuable course of lectures as passed.

The lectures will be printed in the *Journal* ıring the summer recess.

HOWARD LECTURES.

On Friday evening, 17th inst., Prof. W. AWTHORNE UNWIN, F.R.S., delivered the xth and last lecture of his course on "The evelopment and Transmission of Power om Central Stations."

On the motion of the CHAIRMAN (Professor yrton, F.R.S.), a vote of thanks was passed the lecturer for his important course of ctures.

The lectures will be printed in the *Journal* ring the summer recess.

UNION OF INSTITUTIONS.

The following institution has been received o union since the last announcement:—

Free Lecture Society, Science and Art Classes, rtford, Kent.

Chicago Exhibition, 1893.

Sir Henry Trueman Wood, Secretary to the yal Commission, left Liverpool by the *City of Paris*, on Wednesday, 22nd inst., for Chicago, to take charge of the arrangements for the British Section.

SOCIETY OF ARTS EXCURSION TO CHICAGO.

The Council of the Society of Arts, acting as the Royal Commission for the Chicago Exhibition, have arranged with Messrs. Thos. Cook and Son to organise a special private excursion to the Chicago Exhibition for members of the Society of Arts. The excursion will last from July 22nd to August 23rd, and will cost £65. The number will be from 25 to 100. Members will be enrolled according to priority of application. Members may be accompanied by not more than two members of their family, the full fare for each person being paid. Special arrangements will be made by the Royal Commission for the reception of the visitors at Chicago.

Detailed particulars of this tour have been sent to the members, but further particulars may be obtained on application to the Secretary.

Members intending to join the party should send in their names without delay.

Proceedings of the Society.

INDIAN SECTION.

Thursday, February 16, 1893; Sir FRANK FORBES ADAM, C.I.E., in the chair.

The paper read was—

THE PROGRESS OF INDIA UNDER THE CROWN.

By SIR WILLIAM WILSON HUNTER. K.C.S.I., M.A., LL.D.

During the fourteen years preceding the transfer of India to the Crown, a change had taken place, almost unperceived, in the fundamental problem of British rule in that country. Everyone would see that those years had added about 200,000 square miles to the Company's dominions. But very few realised how profoundly the geographical position of the newly annexed territories affected the military foundation of our power. Great Britain had conquered India from the sea; it had held India from the sea-board; and up to 1846 its advance into the interior had been so gradual that the sea-board remained a thoroughly effective base. The rapid con-

quests and annexations in the following ten years left little leisure for strengthening the line of communications between that base and the three distant inland regions which were then added to the British Empire of India. To the maritime populations, the sea had been the visible symbol of an apparently inexhaustible reserve of fighting force at the command of their foreign rulers. Its mysterious capacity for bringing forth fresh and fresh battalions at each critical moment in our history, formed part of the spell by which we held India. But the new populations whom Lord Dalhousie subjected, whether in the landlocked kingdom of Oudh, or in the recesses of the Central Provinces, or in the far-off Punjab, knew little about the sea, and had never come under the spell.

Lord Dalhousie clearly discerned the dangers of the situation. He saw that the line of communications with the British base on the seaboard was lengthened out and attenuated to a perilous degree. Any accident might snap it in two. He saw that this line, thus weakened by geographical stretching, was further enfeebled by the fewness of European troops along its course. At present, the proportion of British to native soldiers in India is one to two. Before 1857 the proportion was only one to six, and along the critical line of communications in Northern India it fell at places as low as one British soldier to 24 natives. Many of the forts and arsenals were practically in the keeping of native troops. The artillery was also to a large extent manned by natives.

Lord Dalhousie perceived, moreover, that the danger was not a military one alone. He realised that the vast and rapid extension of territory which had taken place during the ten years preceding 1856, must severely strain the cohesive powers of the British Empire in India. The danger was both from without and from within. On the frontier, the old native powers which, in Sind and in the Punjab, formerly stood as breakwaters between the Company's dominions and the warlike races beyond, had gone down before our arms. British India, for the first time, stood face to face with Central Asia, and new barriers would, sooner or later, have to be raised against Afghan turbulence and Russian intrigue. In the internal conduct of the Empire he perceived that the control of the Central Government, if it were to remain effective, must be modified, not only in degree but in kind. That the obedience of the subject populations must be secured by consolidating influences, some c them novel in character, all of them to b exercised on a scale never before attempted i India.

Dalhousie saw all this, and he did wh a great ruler of men could do to mal others see it also. He inaugurated system of railways which should strengthe his long drawn-out line of communicatio in Northern India, and enormously increa the striking power of the British armame at any point. He inaugurated a syste of telegraphs, which should counteract tl dangers of geographical distance. He inst tuted, under John Lawrence, a vigorous watc and ward along the new frontier. He d manded, again and again, from the Hon Government, an increase to the Briti troops in India. His last solemn act, b fore laying down his office, was on more to urge this necessity, and to pre for a re-organisation of the overgrown nati army.

Nor were the measures of internal co solidation effected during his rule of le importance. Up to his time, the Governo General was vested, not only with the co trol over all India, but also with the Gover ment of Bengal. That is to say, he was n only responsible for the general manag ment of the British Indian Empire, but al for the direct administration of its largest pr vince, a province containing one-third of t inhabitants of the whole. Under Lord D housie, Bengal was erected into a separ Lieutenant-Governorship, and the Govern General in Council was set free for a m effective regulation of imperial interests a imperial affairs. Under Lord Dalhousie, al public instruction was organised on a sc which should eventually bring the races India under the influence of Western ideas government and Western modes of thought. Dalhousie India owes what we may n strictly call her penny postage; and to period, although not so directly to hims, she owes that new sense of solidarity which growing out of a widely-spread system of St education.

By these, and other measures and propos, Lord Dalhousie sought to secure and to bi together the Empire, to which such v additions had been made. But while military proposals lay gathering dust in pigeon-hole in a London office, and before measures of consolidation could work out th results, the accident which had always be

ossible, happened. The Mutiny burst upon Bengal, the long attenuated line of the British ommunications was broken by a broad gap, he power of control was wrenched from the ands of the Central Government throughout xtensive provinces.

Exactly 150 years previously, a calamity on n equal scale, and arising out of somewhat imilar causes, had befallen the ruling race in ndia. In 1707 the Mughal dynasty had prac- cally fallen, with its line of communications om its base snapped in two, with its Central overnment powerless to control the new ingdoms which it had conquered, and with he Hindu military races, whose aid had endered possible those conquests, in revolt. he Indian princes and peoples might well sk themselves in 1857, whether the end of he British domination had not, in its turn, rrived. The troops of the ruling race were ar fewer in 1857 than in 1707; they were more olated, and hemmed in by a more numerous nd better disciplined enemy; any succour to hem seemed infinitely more remote. But such alculations omitted an important factor, in- eed, the overruling factor, in the situation. or, in 1707, the ruling race in India were Mughals; in 1857 they were Britons, who new how to die but never to despair, and ith whom disaster and defeat were only a reparation for victory.

The Mutiny was quelled, and, in 1858, India assed to the Crown. The past thirty-five ears have been spent in three great tasks— making the British Empire of India safe, making her peoples prosperous, and also, ank God, in making them loyal. The ssential history of India during that period ay be summed up in two words—defence and evelopment. The British rulers of India etermined that never again should their line communications with the sea-board be cut two. No sooner was the first tumult of the utiny stilled, than Lord Dalhousie's scheme binding together the provinces of India by great net work of railways was pushed rward with renewed vigour. This vast work consolidation must be dismissed in a couple sentences, for many pages would be required bring home to the understanding, or even to e imagination, of an English audience, the full gnificance of what has been accomplished. I all, therefore, only say that in 1857, there ere 300 miles of railway opened in India; in 92 there were about 18,000. Distances which, 1857, occupied a three months' march are w covered in three days; and the whole military resources of the Indian Empire are rendered available by a net-work of railways for the protection of every part.

The first duty thus imperiously imposed by the Mutiny on the governing power was to make India secure. The Mutiny had cost many more Indian lives than European lives; it led to a far more widely spread plunder and de- struction of native than of European property; it left behind, on the shoulders of the innocent Indian taxpayers, a burden of £42,000,000 of new debt. We had disarmed the races of India, and we were bound to assure the safety of the peoples from whom we had taken away the means of self-defence. The basis of all sound and permanent progress in India is the safety of India. I have so often dwelt on that pro- gress, and I have again this afternoon so inspiring a narrative of progress to relate, that it is right, first of all, to explain at some length the solid foundation of force on which the marvellous superstructure of Indian prosperity now rests.

No time was lost in carrying out Lord Dal- housie's view in regard to the increase of British troops in India. Broadly speaking, the number of British troops was doubled; while that of the native troops was reduced to one-half. The native army was remodelled, both as to its material and its organisation. The Sikh, the Gurkha, and the Pathan have largely supplanted the pampered sepoy of the middle valley of the Ganges and Oudh. The native army thus recruited from hardier materials, is also better organised. Not only has the fight- ing value of each battalion been greatly in- creased, but it is so composed as to render combination of its units against authority much more difficult.

A full quarter of a century of peace within India, and the absence of any serious danger from without, enabled the long task of re- modelling the army to be thoroughly accom- plished. In 1881, the British troops numbered 60,000, against 110,000 natives—total, 170,000 —and almost every object connected with the reconstruction of the Indian army for the pur- poses of internal security had been attained. But, during the 12 years which have followed 1881, the military problem in India underwent a change. The steady advance of Russia in Central Asia, and her contact with the States on our North-Western frontier, transformed the freedom from external danger, which India had previously enjoyed, into a condition of affairs approximating to that among the great armed States of Europe. The new order of things thus

brought about has, during the past eight years, been emphasised by such episodes as those of Penjdeh, the Pamirs, and the recent conflict of Russian and Afghan troops. That new order rendered not only an increase in the Indian armies, but also a higher standard in their fighting efficiency, absolutely necessary for the safety of the British Empire of India.

The improvements in efficiency have been effected by means of better weapons, a stronger force of artillery, and a more complete equipment and organisation for the actual purposes of war. The increase in numbers has been economically carried out by quietly augmenting the strength of the British regiments of cavalry and infantry, and by adding eleven batteries of artillery and three battalions of infantry. Corresponding additions have been made to the Native Army. In 1891, the combined forces had been raised to over 71,000 British and 149,000 Natives; total of regular army, 220,000; or 50,000 more than in 1881. But the addition has not been to the regular armies of India alone. For the feudatory princes of India realised the new danger as keenly as the British Government, and of their own free will they now maintain a body of Imperial contingent troops, at present 14,000 in number, but eventually to be raised to 21,000, besides transport corps and sappers. A new voluntary force of Europeans has also grown up. The Anglo-Indian and Eurasian volunteers in 1891 numbered 23,000, including cavalry and infantry, of whom 20,000 were declared efficient. A reserve system has been organised alike for the native army and for the European volunteer corps. In 1891, 7,000 time-expired soldiers of the native infantry, and 2,180 European volunteers, stood on the roll of the reserve.

To sum up, the Indian army at the end of 1856 was reported at 40,000 European, and 245,000 native soldiers, including contingents serving in native States; total, 285,000. The proportion was one European to six natives. Even this inadequate proportion was not maintained, and it was extremely weak at the strategical points where it should have been strongest. In 1891, the Indian army consisted of 96,261 Europeans, including regulars, volunteers, and volunteer reservists, with 170,192 natives including regulars, feudatory contingents, and native infantry reservists; total 266,453. The aggregate total is smaller than in 1856. But the proportion of European to native soldiers, in the regular army, is one to two, instead of one to six. In the subsidiary forces of reservis and volunteers—taking the feudatory co tingents as the native counterpart of t European volunteers—the proportion is o European soldier to one native. The fo resses, arsenals, and all the main strat gical positions in India are now secured British troops; and the artillery is almo entirely a British force.

While the army of India has been co pletely reconstituted on a safer and mo efficient system, another lesson painfu learned during the mutiny has borne fru That lesson was—that given a tenable place refuge, even a handful of Englishmen cou hold it against overwhelming odds till succo arrived. Before Sir Donald Stewart laid do his command, at the close of his distinguish career in 1885, refuges had been either co structed or arranged for at many local centr of European population in the Bengal a Madras Presidencies. The next Command in-Chief, Sir Frederick Roberts, had lo urged the necessity of such refuges. In 18 1890 arrangements were made for having clear front of fire round these defences, a steps were taken to secure the right of p venting the erection of buildings which mig weaken their position. In 1891, a detai system of yearly confidential inspection by senior Artillery officer and an officer of e Royal Engineers was elaborated.

Confining our attention to the main line f communications which was so fatally cut n two in 1857, the following summary of defe e works will suffice to indicate what has b n effected during the past few years. At De , a scheme for improving the fort defences h d been practically carried out by 1890, with e exception of some of the fortifications for e protection of the railway - bridge over e Jumna, which were finished in 1891. At Ag, a block-house to defend the left abutmen of the railway-bridge over the Jumna, was c-structed in 1889-90. At Cawnpur, block-hou s to defend the Ganges-bridge were elabora d in 1889-90, and completed in 1891. At Al-abad, block - houses to defend the railw-bridge were commenced in January, 1890, d completed in the following year. At Lu-now, after long and repeated discussions f m 1864 onwards, two redoubts commanding e main positions were finished in 1888 an n 1891; and the subsidiary defences of e Bhoosa Godown are also practically c-pleted. These, and the blockhouses at Fa-garh, Firuzpur, Jhansi, Kalpi, and e

Jhelum River, all of which are now finished, may serve as an illustration of what has been done during the past few years to prevent the British positions in India from ever again being rushed as they were rushed in 1857. I regret to add that the isolated European centre of Cuttack, the capital of Orissa, is said, through want of funds, to be still left without really effective means of defence.

The internal safety of India has thus been secured by a reconstitution of her army, and by a widely-spread unobtrusive system of local defence works, scientifically planned, and vigilantly inspected—a combination of living strength of control, and of physical difficulties placed in the way of revolt, which not even Dalhousie would have ventured to think possible when the Government passed to the Crown. But in regard to material defence works as in regard to the organisation of the army, the safety of India is no longer a problem of internal protection alone. The long land frontier of the North-West, whose difficulties were only emerging in Dalhousie's time, is now recognised to be one of the heaviest responsibilities of the British rulers of India. In October, 1885, the Secretary of State for India gave his general approval to a plan of frontier defence, carefully elaborated by Sir Donald Stewart, then Commander-in-Chief. That plan included, among other fortifications, an entrenched camp at Peshawar to close the mouth of the Khaibar Pass; a similar entrenched position in the Pishin Valley; the improvement of the defences of Kandahar; a strong work at Multan to secure a depot of supplies; a defensive position at Sakkar, to protect the bridge across the Indus; certain defences of the Gomal and other passes, and a fortified arsenal at Quetta; together with important strategic lines of railway. This plan underwent changes on further discussion, and in January, 1887, the Secretary of State gave his general sanction to the scheme on which the frontier defences have, during the past six years, been carried out. The works to be constructed, apart from railway communications, arranged themselves into three groups. Those intended to prevent an enemy from advancing on Kandahar by Quetta and the Bolan or Pishin lines. Those for the defence of the Khaiber pass, and its *debouchure* on India. Those intended for the protection of certain strategical points in rear.

The first series, or the Quetta defences were practically completed by 1891. The main line of the Quetta defence is a strongly intrenched position in front of Quetta, covering the railway junction, and barring the approaches towards India, leading from the various passes which here converge towards Quetta. An advanced post at New Chanam, six miles on the Kandahar side of the Khojak-tunnel, covers the terminus of the railway which keeps our frontier in direct touch with the whole military resources of India. I need not detain you with the defensive works in detail. The tactical points throughout the main position are occupied by batteries and flanked by redoubts, with intervening lines of infantry trenches. At Quetta itself, a second-class arsenal has been established; the old fort has been practically reconstructed, and now affords protection for the ordnance stores.

While the road from Baluchistan has thus been effectually blocked at the entrance, the Khaibar Pass is secured on a different principle. Political considerations render it at present impracticable to construct extensive fortifications at the western or outer end of the Khaibar Pass. With the exception of small works, as at Landi Kotal and Jamrud, and the improvement of the Bala Hissar Fort at Peshawar, finished in 1889, the Khaibar Pass has been commanded by an inner line of defence, chiefly represented by the Attock and Rawal Pindi positions. The proposal to close the Pass by means of an entrenched camp at Peshawar has not been found practicable. The nearest position of great strength is at Attock, where, after protracted discussion and several intermediate changes, the line finally selected consists of an arc about $7\frac{1}{2}$ miles in length, both flanks resting on the River Indus at points four miles apart. The position comprises a series of batteries commanding the lines of approach, and flanked by infantry redoubts and lines of entrenchments. The works are expected to be completed in June, 1893.

The main defensive position on the line of the Khaibar lies still further back at Rawal Pindi. Extensive alterations were carried out in the Rawal Pindi Arsenal during 1884-85, and the scheme matured in 1888 by the defence committee was eventually as follows:—1. The defences of the Rawal Pindi position to consist of a quadrilateral with sides about five miles long, enclosing the cantonment, city, and arsenal, guarding the communications in rear, and adapted to resist attack from any side. 2. The four salients of this position to be strongly held, and to rest on infantry redoubts capable of independent defence, the Misrial position at

the north-western angle being especially strengthened. 3. The curtains, on the north, east, and west sides, to be further strengthened by selected infantry and artillery positions, to which radial communications would be opened out.

At Rawal Pindi, as at Attock, delay occurred owing to a misapprehension regarding the proposals of the Defence Committee, resulting in the commencement of works on too extended a scale; but it is expected that the whole will be completed by the end of 1893.

While the two great entrances into India, by Quetta and the Khaibar, are thus guarded, a carefully planned inner line of defence has been made strong. The main strategical points in the rear, at which fortifications have been completed, are at Sukkur, commanding the railway-bridge across the Indus, Multan, Firuzpur, Shershah, and Bahawalpur. The whole north-western frontier line of British India, over 800 miles in length, is now reasonably secure.

The coast defences of India have also been placed on a sound footing. A scheme was initiated by Sir Donald Stewart simultaneously with his scheme for strengthening the north-western frontier, and it has been extended and worked out under Lord Roberts. The defences of the great ports of Aden, Bombay, Karachi, and Calcutta are now practically complete. Those of Rangoon have been retarded by differences of opinion, and by the treacherous nature of the soil, which makes the preparation of heavy gun emplacements a work of extreme difficulty, and one involving long delay. Proposals for defending the minor Indian ports of the Madras roadstead, Port Blair, Akyab, Bassein, Chittagong, and Moulmain have also been considered, and, in some cases, schemes have been approved. But financial obstacles, together with the difficulty of providing men and officers to work the proposed armaments, if supplied, have hitherto stood in the way of their execution. The great coast defences of India are, however, now almost complete.

India, under the Crown, has thus been rendered secure within, and, as far as possible, safe from without. The solvency of the finances formed the second fundamental duty of the British rulers. Since the country passed to the Crown, the appliances of a civilised government—public offices, court houses, jails, schools, hospitals—almost the whole material fabric of the modern Indian administration, have been built or rebuilt on a large scale. In spite of these two heavy sets of expenditure thus involved, military and civil, th finances have prospered. Comparisons be tween revenue and expenditure at differer periods in India are rendered difficult b changes in the system of accounts, and b alterations in the value of silver. In suc comparisons, therefore, I confine myself to th results authoritatively presented to Parliamer by the Blue Book, in 1889,* premising tha progress has gone on steadily since the date t which its figures refer. I express all larg sums in Rx., or tens of rupees, the form no adopted in the Parliamentary statements; s that, when I say 50,000,000, I mean nc 50,000,000 sterling, but 50,000,000 of Rx., tha is, of tens of rupees.

Speaking on this authority, and expressin large totals in this form, the following are th main results. The finances of India emerge from the Mutiny of 1857, in a state of appa rently chronic insolvency. During the 20 year before the mutiny, there had been 14 year of deficit and only six of surplus, yielding net deficit of Rx. 18,626,000, and an addition c Rx. 16,737,000 to the debt of the country. Th Mutiny resulted in four years of terribl financial strain and unbroken deficit, addin another Rx. 42,000,000 to the public debt. Bu meanwhile, the new financiers sent out unde the Crown had been hard at work, and, i 1861-62, financial equilibrium was practicall restored. During the quarter of a centu which followed, there were fourteen years c surplus and eleven years of deficit, yielding net surplus of Rx. 6,000,000. Since then, th four years ending 1891 showed three years c surplus against one of deficit, yielding further net surplus of Rx. 4,000,000. "Th public debt of India, apart from capital" in vested in railways, public works, &c., wa returned by the Parliamentary Blue Book c 1889† at "67,000,000, as against 51,000,00 before and 93,000,000 after the muti period"—showing a reduction of 26,000,00 of debt in the twenty-five years from 186 India, under the British Crown, has bee rendered not only safe, but solvent to a degre never attained under any previous governmen At the commencement of the period India ha to pay interest on its debt at 4 to 5½ per cent it can now borrow at a little over 3 per cent.

One cause of the improvement in the India finances is a greater economy in expenditur Money is made to go further. The decentra

* "Indian Administration during the past thirty years." C. 5713.

† C 5713: par. 32.

sation of finance, while reserving intact the control of the Government of India and of the Secretary of State, has produced two results. It has rendered that control more really effective by divesting it of ineffectual interference in petty details. It has also enlisted the Provincial Governments on the side of a vigilant economy. by securing to them the gains accruing from economy and vigilance. But the main cause of financial improvement in India has been the steady growth of the revenue, due not to new taxation, but to the increase of the population, and to the still more rapid increase of material prosperity. Comparing the data afforded by the Blue Book of 1889, the total revenue of India, in 1856-57, was Rx. 33,378,000; thirty years later it had nearly doubled to Rx. 62,859,000, apart from capital outlay on railways and from municipal funds. "This is nearly double the revenue of the period before the Mutiny yet," says the Blue Book of 1889*, "the increase is almost entirely due to the growth of revenue under old heads." In 1891, it had increased to about Rx. 64,000,000; and the total gross revenue, including railways and irrigation receipts, &c., was Rx. 85,750,000.

The only new revenues levied during this period of vast increase, says the Blue-book of 1889, have been the income tax, the provincial rates, and the forest receipts, yielding a sum not much greater than the old taxes, from customs, salt, and inland duties, abolished or reduced since the close of the Mutiny period, in 1862. New local imposts have been levied for local, municipal, or port improvements since the Mutiny; but they are entirely expended by local bodies on local objects, such as roads, harbours, schools, hospitals and town improvements. The increase of revenue has been mainly the direct result of the increase of the population, and of the means of internal development, such as roads, railways, and irrigation works. This is well seen in the expansion of the land-revenue or rent, which the Government of India derives from the State ownership of the soil. The gross land revenue has risen from under Rx. 18,000,000, in 1857, to over Rx. 24,000,000 in 1891. But while the rent paid by the people to the Government has thus increased by one-third, the value of the produce of their fields has more than doubled. This is partly due to the higher local prices, and partly to the enormous increase in the area of cultivation.

* C. 5713, par. 33.

Since 1856, the year before the Mutiny, the cultivated area, according to the Blue Book of 1889, has more than doubled in thinly-peopled tracts like Burma and Assam in thirty years; it increased by 20 to 30 per cent. in the Central Provinces, Berar, and parts of Bombay; and by 20 per cent. even in the densely-peopled province of Oudh. The number of cultivators has also increased by at least one-third for all India during the same period. New and profitable crops have been introduced; the standard of living has risen among the agricultural classes; occupancy tenant rights have been recognised by law over almost all India; imprisonment, sale of land outside the permanently settled Districts, and other of the old harsh processes for the recovery of arrears of land-revenue, are much less common; while the land-revenue itself is more punctually paid.

The same natural increment from the increasing numbers and prosperity of the people is disclosed under other general heads of taxation. While, therefore, the land revenue has greatly increased, it is not so exclusively the main dependence of the Indian Exchequer as before the Mutiny. In 1856, the land revenue formed over one-half of the gross revenues of India, it is now less than one-third; so that the public income rests upon a broader basis, and is augmented by the growing prosperity, not alone of the agriculturalists, but of all classes of the people.

I must pass rapidly over the epoch-making changes in the internal administration of India under the Crown. In finance, a system of Annual Budgets was introduced in 1860, with sanctioned grants for each sub-head in every province and district. The principle was laid down that there should be no new taxation without legislation. When the Budget estimates for any year involved legislation for the reduction or increase of taxation, they were to be laid before the Legislative Council. This system has gradually developed until, under Lord Cross's Act of 1892, it is now finally settled that the Budget statement, whether involving new taxation or not, is to be annually brought forward in the Legislative Council for discussion. Passing from finance to legislation, the whole existing system of the Indian Legislature was remodelled in 1861; and, after 30 years of careful watching, it has been expanded on a wider and more popular basis, alike for the Supreme Government of India and for the Provincial Governments, by Lord Cross's Act of 1892. Under the Crown, also, a magnificent series of Law Codes has been passed,

consolidating the whole Empire of India under a common system of jurisprudence. "The progress of India," wrote Sir Henry Sumner Maine, "in the simplifiation and intelligible statement of law has been greater than that of any Western country, except, perhaps, the German Empire. . . . In force, intelligibility, and in comprehensiveness, the Indian codes stand against all competition. These codes are wholly the growth of the period during which India has been governed by the Crown."

Next to sound finance, a wisely constituted legislature, and a clear and uniform system of law, come an accessible system of Courts of Justice and a vigilant police. The law courts of India, from the highest to the lowest, have been remodelled uuder the Crown. But the great improvement in the actual administration in justice is due not so much to changes in system, but to the growth of a highly trained and thoroughly upright body of native judges and magistrates. Nine-tenths of the original civil suits, and more than three-quarters of the magisterial cases, now come before the native judges and magistrates. "Thirty years ago," the Parliamentary Blue Book of 1889 declared, "few of these officers knew English, none of them had obtained a university degree, and hardly any had enjoyed any legal training. At the present time nearly all civil judges in the older provinces know English, and many are university graduates in Arts and Law. . . . . . With the improvement in education and in salary, has come a much higher standard of probity and sense of duty among native judges and magistrates. A generation ago, public officers of this class were often accused or suspected of corrupt motives." At the present time such accusations are almost unknown. While the character of the stipendiary judicial staff has thus improved, a wide-spread system of unpaid magistrates has developed. In 1856, such magistrates, where they existed at all, discharged little judicial business. There are now over 2,000 honorary magistrates in India, chiefly native gentlemen, who deal with a vast amount of minor business in towns and rural tracts, and give satisfaction to the people both by their procedure and their decisions.

The police, also, has been completely reorganised, by a series of legislative enactments, since India passed to the Crown, commencing with the fundamental Police Act of 1861. As a source of security, the new system has been an unqualified success, and 170,000 armed police, drilled and officered by Europeans, now render it impossible to rush the jails or th small isolated British stations as they wer rushed in 1857. The new police have als been successful against the most seriou crimes of violence. Gang-robbery, *thagi* an *dakaiti*, and the various organised forms c depredation which formerly afflicted th peasantry, have been fairly well put dowr But against the smaller class of offences, th Indian police are less successful, nor hav they yet purged themselves of a widesprea suspicion of corruption, as the Indian nativ judges have done.

While these improvements in administratio have been taking place, India has bee equipped with a new mechanism of materi development. In 1856, there were only 3c miles of railway opened, carrying during th year 2,000,000 passengers, and $\frac{1}{4}$ million tor of goods. In 1891, the great network of India railways constructed under the Crown en braced 17,283 miles open for traffic, ar carried 121,000,000 of passengers ar 26,000,000 tons of goods. The products every province of India, instead of being lan locked by want of outside communication have now an easy exit to the markets of t world.

As regards irrigation works, when Ind passed to the Crown, the total irrigated ar from all the canal systems was under $1\frac{1}{2}$ milli acres. Since then great series of new wor have been constructed, the old works ha been enormously enlarged, and the area n irrigated from public irrigation works is ab 12 million acres. The same rapid advance h been made in other undertakings for drawi forth the material resources of the count and the Secretary of State was able to decl that "the progress effected with works f material improvement in India has been greater during the [first] thirty years of H Majesty's rule than during the precedi century." As far back as 1886, it was officia calculated that the producers, traders, a passengers of India benefitted from the sin item of cheapness of railway transit, compa with the old modes of travelling, to the amo of Rx. 60,000,000 per annum. This sum ceeds the whole actual taxation taken fr the Indian people, excluding, of cou opium, which is paid by the Chinese c sumer.

The result of all the foregoing causes, a others such as the opening of the S Canal, too numerous to specify here, s

been an expansion of Indian commerce such as the world has scarcely ever seen; and which would have been regarded as an impossible dream in any Asiatic country 35 years ago. In 1858, the Court of Directors reported, with pride, the total Indian exports and imports of merchandise by sea at Rx. 39,750,000. In 1891, the total, excluding treasure, was Rx. 172,000,000, or, including treasure, Rx. 196,250,000. But the increase is not so striking, even in regard to its enormous amount, as in regard to its commodities. In 1858, India was chiefly known as a dealer in drugs, dyes, and luxuries. She is now one of the largest merchants in the world in food-grains, fibres, and other great staples of universal consumption. Most of her old products have expanded, while the new and profitable crops of India, such as jute, wheat, cotton, oil-seeds, tea, and coffee, practically date their great development in the world's markets since the country passed to the Crown. A great mining industry has also developed. India now produces her own coal, and before long will probably produce her own iron and steel. The steam factory has reared its tall chimney in all the capital cities of British India. Cotton mills, jute mills, woollen mills, paper mills, iron foundries, saw mills, and steam pottery works, steam flour mills, and the great steam workshops of the railways and ship-building yards, all combine to make a new industrial era for India.

If anyone would realise the industrial revolution which has thus been effected, he cannot do better than visit the Indian Section of the Imperial Institute at South Kensington. For the first time in the history of India, India's produce will be brought in a practical commercial way, and, as a whole, before the Western world. Each stage of production will be represented by specimens, from the growing plant to the finished fabric, and from the mineral ore to the fine metal work. In one set of rooms the whole products of India will be exhibited in small glass cases; but each small case bears an inscription, which will accomplish two objects. First, it will enable the inquirer to refer at once to the larger store of the commodity, kept in another department for practical examination, and for handling by commercial men. Second, it will refer him to the exhaustive account of the commodity in Dr. Watt's great Dictionary of Indian Products. The scientific and economic aspects of Indian commercial commodities are thus brought to a common focus, and the Indian Section of the Imperial Institute will stand to the British nation as the visible symbol of the new industrial era of India.

The Native Princes have recognised, by liberal donations, the importance of the Imperial Institute as a means of developing the resources of their territories. It is to be hoped that the great producing interests in India, who are even more directly interested, will also now come forward. The Imperial Institute will be not merely a dead collection of specimens. Its programme is to take up each year certain Indian products which appear to merit careful inquiry, and to submit them to examination and analysis by men of science; and to report and valuation by practical business men. If the Indian Chambers of Commerce and great planting, trading, and industrial associations now do their part, as the Indian Princes have done theirs, the success of the Indian work of the Imperial Institute will be secured.

Marvellous as has been the material progress of India under the Crown, its moral and intellectual development has been still more significant. While railways and irrigation works have opened up the resources of the country, a great system of education has awakened new ideas and new aspirations among the people. So much of my life and so many of my published writings have been devoted to this social and political aspect of Indian progress, that I do not venture to again enlarge on it here. In 1855, three years before India passed to the Crown, there was not a single university in India, and the total number of pupils in Government, and Aided, and extra-Departmental schools (so far as known) was under one million. In 1891, thirty-three years after India passed to the Crown, there were five Indian universities at full work, and the number of pupils in schools under Government inspection alone amounted to close on $3\frac{3}{4}$ millions. But again, I repeat that the most important feature of the progress made is not its vast numerical returns—it is its quality rather than its quantity. During those thirty-three years, female education, as an effective factor in the life of the educated classes, may almost be said to have been created. A powerful native Press has sprung up, which now sends forth 463 vernacular newspapers besides many native journals in English. A great vernacular literature under Western influences has come into existence. In 1891, the registered publications alone numbered 7,885 books or pamphlets, of which over 7,000 were in the

Indian languages, and 668 in the English tongue.

This far-reaching intellectual activity is profoundly affecting both the social life and the political aspirations of important sections of the people. The ancient caste-system of India has been brought to the bar of modern Indian public opinion; from the religious obligation of child marriage to the religious prohibition against sea voyages by Hindus. At the Chicago Exhibition this year, the most striking Indian exhibit will be not the fibres, nor the fabrics, nor the food grains, nor the tea, nor the iron work, nor the coals of India, but a complete ship-load of Hindus, who, after a full and public discussion of their caste restrictions on sea-voyages, have chartered a steamer for America with the public approval of leaders of the Hindu community and of the Hindu Press. Such an expedition would have been regarded as an impious impossibility 33 years ago.

Nor are the political aspirations of the educated classes in India producing less striking results. Since the Act of 1861, native gentlemen have formed an important element in the legislative councils both of the Supreme and the Provincial Governments. Under the Act of 1892 they will form a still more important element; and in 1892, also, a native of India was, for the first time, returned to the House of Commons. In the practical administration of the law, native judges have taken their place under the Crown in all the supreme tribunals of India, as High Court judges. In the subordinate ranks of the judicial administration, the Blue Book of 1889 stated that out of 2,588 judges and magistrates, no fewer than 2,553 were natives of India (including 104 Eurasians) and only 35 were Europeans. Indeed, under the Act of 1879, no person who is not a native of India (or a member of the Covenanted Service, or the Staff Corps) can be appointed to any judicial or revenue office, carrying a salary of Rs. 200 or upwards a month, without previous sanction as a special case from the Secretary of State, as regards certain Provinces, or, as regards the other Provinces, from the Government of India.

The Covenanted Civil Service is open alike to all subjects of the Queen, and although it has not been found possible to meet the request for simultaneous examinations in England and India, efforts have been made, by raising the limit of age, to enable Indian gentlemen to compete under more advantageous conditions in England. A Native Statutor[y] Civil Service was attempted in India, not quit[e] successfully; and the Public Service Com[-]mission has dealt with the whole question [of] the re-constitution of the Indian administrativ[e] body on a basis thoroughly equitable to th[e] natives. Meanwhile local self-government which is the best preparation for public life, ha[s] made important progress. The Indian Munici[-]palities, to which our Chairman, Lord Ripon gave so memorable an impulse, had under thei[r] administration in 1891 a population exceedin[g] 15,000,000; and of the 10,585 members wh[o] sat on their boards or councils, more than one half were elected by the ratepayers. Th[e] representative principle is now being cau[-]tiously extended, under Lord Cross's Act [of] 1892, to the Legislative Councils both of th[e] Supreme and the Provincial Governments.

While this many-sided expansion has bee[n] going on in the regular administration, a non[-]official representative body has organised itse[lf] for the loyal expression of the wishes of th[e] Indian people. Each December about 1,00[0] delegates from the various Provinces assembl[e] at some great city of India, to plainly, bu[t] respectfully, state their views. Before th[e] country passed to the Crown, such an India[n] National Congress could never have com[e] together; and if such a body had attempted t[o] assemble, it would have been forcibly dis[-]persed. It now meets without danger either t[o] its members or to the Government. Its merit[s] and its mistakes are impartially criticised what is wise and good in its recommendation[s] is fairly considered; and the ruling power in India and in England, have shown them[-]selves willing to allow a cautious and saf[e] advance in certain of the directions pointed ou[t] by the Congress. For the ruling power is no[w] strong enough to be able to listen without fea[r] to the wishes of the people. It recognise[s] that the loyal expression of their opinions, an[d] their desire for an increasing share in th[e] administration and legislation of India, ar[e] sources not of danger but of additiona[l] strength.

In thus rapidly summarising the progress o[f] India under the Crown, it almost seems as i[f] the success had been too complete. But i[f] for a moment the story of Polycrates, as tol[d] by Herodotus and sung by Schiller, come[s] discordantly to memory, we have only to loo[k] more closely at the India of this moment, i[n] order to dispel the dread of a prosperity too un[-]broken, or a good fortune beyond the limits tha[t] can be accorded to man. Great as have bee[n]

our achievements in India in the past, scarcely less great are the difficulties to be overcome in the present. The increasing pressure on an already over-burdened soil by a population which marries in childhood, and brings fresh children into the world as a religious duty, without any regard to their means of subsistence, involves an intensifying problem of poverty and a perpetual risk of famine. The new industries by steam-power have inevitably displaced some of the old industries by the hand; and while there is much to encourage us in the industrial India that is now growing up around us, there is also something to regret in the industrial India which has passed away. To the serious Currency problem, which has so lately occupied the attention of this Society, I need only refer. The truth is that our position in India always has been, and always will be, full of difficulties. This lecture, however, as its title declares, is a record not of obstacles but of progress. The fundamental condition on which we hold India is the courage to face and the power to conquer great difficulties. That courage and that power have never failed the British nation in the past, and so long as our nation remains true to itself, they will not fail it in the future.

DISCUSSION.

Sir Owen Tudor Burne K.C.S.I., said he had much pleasure, as a vice-president of the Society, in saying how much it appreciated the kindness of Sir William Hunter in taking so much trouble to prepare this valuable paper; and he must congratulate him on his undiminished enthusiasm in the cause of India, as well as on past efforts which had done so much to produce the progress he had been describing. He should be only too glad if Sir William Hunter could be brought from Oxford, and placed in closer relationship with those who had to decide the highly complex questions of Indian administration. All would agree that the basis of all sound and permanent progress in India was to ensure its safety. We had been placed in India by an overruling Providence, and had bestowed great blessings upon a country which formed one of the brightest possessions of the Crown. But we had two great duties to perform: one, to protect India against outward aggression and inward commotion, and the next, to do all we could to gain the respect and friendship of those great races over whom we had been called to rule. He claimed, on behalf of the Viceroys and administrators of India, that those two considerations had always been kept in view by them. There was a vast difference between the India of former times and the India of the present day. Before 1858, our policy, which was forced upon us, and which was justified by events, was one of annexation and of putting one province or race against another; but, since that period, the whole thing had changed, and the endeavour now was to unite and consolidate the Empire. This policy had been favoured and accelerated by the action of certain European powers, who, by advancing on India, thought they were going to disturb the whole country, but, as it happened, were uniting it in one defensive policy. Not only did the native races give large sums towards the national defence, but the native States came forward and offered their armies and assistance. On the military question, he must say that he was one of those old-fashioned military men who regarded India as a country as large as Europe dominated by comparatively a handful of men, and he, therefore, doubted the wisdom of covering it with enormous lines of fortifications. Sir William Hunter mentioned the fortification of Rawal Pindi as a quadrilateral of five miles; this was a place which would require 10,000 men to defend, but he preferred a moving army, which could go about the country when required, with a certain number of small fortified positions, that could be easily held, and which would form, in case of need, refuges for women and children, and serve as arsenals. He was very glad that Sir William Hunter had mentioned the Imperial Institute, of which he had the honour to be one of the Governors. He hoped that, when it was opened by her Majesty, which was expected to be in May, they would be able to carry out the objects which Sir William Hunter had described, and that the institute would form a worthy memorial of the Queen's Jubilee. They had recently affiliated to it the Northbrook Society, which was formed for bringing Indian and English gentlemen into closer connection, by arrangements which entitled the members to fellowship of the Institute on most favourable terms. Without detaining the meeting longer, he would again say that he claimed for every Viceroy and every Government official that they had done their best for that great country; and he would conclude by saying in the language of a Blue-book, that the policy, progress, and requirements of India had been investigated by competent critics of many countries, and the general verdict had been that, despite mistakes and shortcomings such as were inseparable from human effort, the administration of India by the Crown had been an earnest and fairly successful attempt to solve political, social, and material problems of much difficulty and complexity.

Mr. R. B. Buckley said he was a member of the Public Works Department of India, and naturally took most interest in matters connected with it. Reference had been made to the necessity for preserving India from enemies, both external and internal; but one enemy had not been mentioned, and that was famine. War might destroy thousands, but famines in India had destroyed millions. During the time India had been administered by the Crown, great

efforts had been made to fight that enemy, and, as an irrigation officer, he should like to somewhat amplify the figures Sir William Hunter had given. Irrigation was required in about one-sixth of the total area of India in order to secure the crops. There were about 154,000,000 acres of cultivated land, of which statistics were available, and it was estimated that 30,000,000 acres of this area were irrigated in some way — not entirely by public works, but partly by wells and other sources. Even where it was not absolutely necessary, it increased the crop from 30 to 50 per cent.; the same ground which would yield 800 lbs. of wheat per acre unirrigated, yielding 1,200 lbs. when irrigated. The development of this system, therefore, would go far to meet the difficulty of increasing population which had been referred to. The introduction of irrigation works had also a great influence in pacifying restless tribes and rendering them contented, as had been proved in the Punjab, at Peshawar, and elsewhere, and the same thing was going to be tried in Burma. Statistics showed that the following proportions of the population were protected by irrigation from any fear of famine:—In Bengal, 5·2 per cent.; in the North-West Provinces, 13; in the Punjab, 26; in Madras, 20; Bombay and Scinde, 17. This measure of protection might appear small, but in Bengal, for instance, there were large tracts where the crops were permanent and certain. The total amount expended on all classes of irrigation works was Rx. 33,000,000, and the actual net returns last year were Rx. 2,000,000, or over 5 per cent. on the capital expended.

Sir WILLIAM WEDDERBURN said he had listened with great pleasure to the paper, but he differed from the author on some points, especially with regard to the very bright view he took of the condition of India. He regarded him, nevertheless, as a true friend to the Indian people; and in no respect had that friendship been more manifested than in the large amount of information with regard to India which he had disseminated amongst the English public, especially the rising generation. The paper dealt mainly with two subjects, defence and development. A great mistake was commonly made with regard to the safety of India. They often heard about the danger of losing India, but the greatest danger arose from the habit of regarding India as a sort of powder magazine, from which we had to warn every one off, and keep them at a distance, officials thinking that any amount of money might be spent in so doing. In his view, that was altogether a mistake. India, properly treated, would not be a powder magazine, but a tower of strength; therefore, while listening with great interest to the account of the line of defence prepared against the Russians, he remembered what had been said by a Russian general, that they did not care about the military preparations on the frontier so much; they looked to the condition of mind of the people behind it; that while the thin red line was facing them, there would be a rising amongst the people of India behind. The real defence of India was to make such a risin[g] impossible. Make the people feel that they wer[e] fighting for their homes and families, and no Russia[n] army would ever cross the frontier. An old India[n] friend of his once said to him, "If the Russians tak[e] India, it is we, not you, who are the chief losers; yo[u] will go on to your ships and be safe in your distan[t] homes, but we shall lose everything, our country, ou[r] liberties, and all our hopes." The best defence of Indi[a] is to gain the affection of the Indian people. Wit[h] regard to the development of India, the figures put for[-]ward were very nice, but what he looked to was th[e] condition of the people; was that condition what [it] ought to be, and what they would all wish it to be[?] He believed it was not, and the people said it was no[t]. There were vast numbers of industrious peasants livin[g] on the very verge of subsistence; and one failure [of] the periodic rains might consign millions to death b[y] famine. That was the view held by the mass [of] public opinion in India; and one could not de[al] properly with the great problem of India withou[t] knowing what the real facts were. The way [to] get at the truth of this matter was not to stu[dy] merely the official reports, which only gave o[ne] side of the case; there should be a proper, imparti[al] inquiry by a strong, independent tribunal. Gre[at] stress had been laid on the great benefits to Ind[ia] arising from the direct rule of the Crown, but the[re] was one great disadvantage which overshadowed t[he] whole. Under the old regime, there was a f[ull] inquiry every 30 years into the condition of Indi[a] before the Charter was renewed. But now that Ind[ia] was under the direct rule of the Crown, there was [no] day of reckoning, and not only were the grievanc[es] of the people unredressed, but they did not even g[et] a hearing. The one thing needed was to get a Ro[yal] Commission appointed, consisting of men of t[he] highest reputation, to make inquiry both here and [in] India.

Sir GEORGE BIRDWOOD rose to order; he su[b]mitted that the speaker was going into questions [of] politics, which could not be discussed there. T[he] Society of Arts had nothing to do with suggestio[ns] for the appointment of Royal Commissions.

Sir WILLIAM WEDDERBURN said he did not r[e]consider himself out of order, but he had complet[ed] his remarks. He would only say again that [a] public inquiry by persons who would comma[nd] public confidence, was the one thing needed for t[he] good of the people of India.

Mr. J. A. BAINES wished to express his gratitu[de] to Sir William Hunter, not only for the prese[nt] paper, but for the help he had so often received [in] his professional work from Sir William's writin[gs]. Every one interested in India must be extrem[ely] grateful to him for making Indian subjects n[ot] only palatable to the English public, but digestib[le]. He desired simply to saw a few words on t[he] progress of population in India. The gene[ral] notion was that it was increasing, if not by leaps a[nd]

ɔounds, at any rate with great rapidity; but the fact was that the increase was much less than in the British Isles, with the exception of Ireland, and less than that of any great country in Europe except France, whilst the material prosperity of the country had advanced at a greater rate. The whole of the facts stated in the paper might be taken as correct, and the deductions drawn were such as those who had studied not only the Blue-books, but the people of India were able to endorse.

Mr. H. M. HYNDMAN rose to utter a word of protest against the exceedingly optimistic view put forward in this paper. He agreed with the vigorous speech made by Sir William Wedderburn, and if a few more Indian officials would take the same tone, there would very soon be a great change. He had come to these meetings time after time, and had heard a succession of intelligent gentlemen, who had administered India, rise one after the other and state how admirably they had administered it. No doubt it was only natural that they should think so. When a man had spent the flower of his life in a country, he liked to believe that it had grown prosperous under his rule, and he did not blame him for this, but he must confess he should like to see some better evidence of prosperity than had been adduced in the paper. In the few minutes at his disposal, it was quite impossible to go through the various points raised, and he could only mention one or two. It was a most remarkable suggestion that Lord Dalhousie was the man who organised the pacification of the Empire.

Sir WILLIAM HUNTER said he spoke of Lord Dalhousie as having brought about the extension and unification of the Empire, not its pacification.

Mr. HYNDMAN said he had read a long series of histories of Lord Dalhousie's administration, and he ventured to think that his annexations were the cause of the Indian Mutiny, that it was really he who brought about the insurrection in 1857, and he arrived at that conclusion from the writings of Indian officials. But what they had to deal with was the state of things now, not 35 years ago, and the figures quoted by Mr. Buckley ought to make anyone pause before coming to the conclusion that India was prosperous. He said there were 154,000,000 of acres supporting 250,000,000 of people. Anyone who knew anything of agriculture, and especially of the poverty-stricken condition of the soil in India, would see what the condition of the people must be under such circumstances. Sir William Hunter himself, in a book published some 12 or 13 years ago, showed that the problem of poverty in India was then troubling him; for he said how were 40,000,000 or 50,000,000 to be kept alive under the miserable conditions in which they were then existing? He ventured to recall to his (Sir William Hunter's) memory those 40,000,000 or 50,000,000, whose existence seemed to be entirely overlooked in the paper. They were asked to congratulate themselves on the extension of railways, but these railways were owned by Englishmen, and from them an enormous revenue was drawn to this country from the people of India. The drain from India to this country was such as not even Rome in the days of the Pax Romana drew from Sicily, Gaul and other places. Such a drain was never known in the history of civilisation as was now being taken from the impoverished people of India, and with no real benefit to the working people of England. If he might say so, he was as much an Englishman as any present, and his family had been represented in India by more than one member. He was not speaking from an unpatriotic point of view, but from what, he contended, was the highest patriotism — the feeling that the well-being of our fellow subjects was our well-being. What he had said now, he never lost the chance of telling the working people of this country, and he was quite prepared to argue the question out fully with any Anglo-Indian administrator present. When famines occurred—and they had been worse under our rule than under any previous rule of which there was any record—and grain had to be taken from one part of India to another to feed the famishing people, the English shareholders were paid a bonus out of the cost of transporting that very grain. This was nothing short of an outrage. He again challenged any Anglo-Indian official to meet him, either in the magazines or on a public platform, and discuss the question of the prosperity or poverty of India.

Mr. TAW SEIN KO said one result of the long period of British rule seemed to him to be the unification of the Indian races. India was about as large as Europe, but inhabited by more diversified races Under native rule, communication was very difficult; roads were very few; and there were no such things as railways and telegraphs. Besides, there was no community of language or interest among the millions of the heterogeneous races, which had now been created by a knowledge of the English language, and by the political connection of India with England. India unified meant a strong India; and the problem was, how to utilise this strong India. Sir William Wedderburn said the best way of governing India was to base the English rule on the loyalty and affection of the people, which was no doubt true. There was also another great problem which the Government had to face; and that was the enormous increase of population. It appeared that the rate of increase was about 3,000,000 a year, which indicated a tremendous pressure on the food supply. He believed the great misery of the Indian people, which had been much dilated upon, might be attributed to the people themselves. The alleviation of such misery was an economic question, in which the enormously increasing population was a most important factor.

Prof. WALLIS regretted that his official duties had prevented his being present at the commencement of

the paper; and he should not have risen except to correct a mistake, which he feared was very general, which seemed involved in the remarks of the gentlemen who represented the Irrigation Department. After studying irrigation in almost every quarter of the world, he stated positively that a supply of water would not increase the crops from year to year. Water would prevent the entire loss of a crop, and thereby prevent famine, but neither in India, nor in any other part of the world, would water continue to maintain a high average crop, unless manure and good cultivation were added.

Mr. A. K. DONALD protested against the optimistic tone of the paper. It seemed to him, even from Sir William Hunter's paper, quite obvious that this optimistic position was altogether unjustified. He said one of the great works undertaken during the present regime had been the defence of India, and he divided that into two branches, defence from the Indian people, and defence against Russians and other outsiders. He said the railway system had been inaugurated evidently for military purposes, to enable troops to be easily moved about, just as much to keep the people of India down as to prevent the country being captured by a foreign invader. It seemed very strange, if the people were so loyal and contented, that such extraordinary precautions should be taken by the Government to prevent the Indian people requiring any knowledge of the military art. The army was practically officered by Europeans, and if an Indian wished to learn anything about the military art he had to go to Russia, or Japan, or elsewhere. He considered the object of the British Government in India was not to pay handsome salaries for judgeships and collectorships, but evidently that was the real object the Government had in view, not the amelioration of the lot of the whole people.

Mr. EDMUND KIMBER said he was perfectly ready to take up the challenge of Mr. Hyndman. Had Mr. Hyndman, or the gentleman who followed him, studied the position of the wholly native armies? He had, and he might tell them that the native princes, by the encouragement and assistance of this country, could put into the field, much sooner than the Russians, over 300,000 men, well equipped and well disciplined. It was all very well to come to a meeting and throw out innuendoes about maladministration, but these questions required to be carefully studied. He should like to know whether Mr. Hyndman had studied the question of railways. He referred to the quantity of produce which the railways carried out of the country, but how many of those railways would have been built if it had not been for the British guarantee?

Mr. HYNDMAN said it was an Indian guarantee.

Mr. KIMBER said it was nothing of the kind, and asked how many millions Mr. Hyndman and his illustrious friends could raise on a native guarantee. The money came out of the Indian exchequer, but who backed the bill? It was really the English taxpayer who bore the burden. The Indian Government now said they could not go on with any more railways until the question of the currency was settled. What did this mean? It meant that India was helpless without the support of this country.

Mr. MARTIN WOOD said the paper contained much which was calculated to fill Englishmen with pride, and Indians with thankfulness, and the Indians were thankful; but, as Sir Owen Burne had said, many questions were raised which could not be settled offhand, and which some of the speakers had shown required to be carefully considered. With all the stores of information at the writer's disposal, the paper necessarily comprised a valuable record of facts though, of course, official optimism might be expected, but there was another side to these questions; as the proverb said, "All is not gold that glitters." The progress of India had been immense, but there had been progress elsewhere also. It seemed to be assumed in the paper that progress had only been in India, and that it had all arisen because of the transfer from Company to Crown. But there was one sort of progress that was not so distinctly brought out by Sir William Hunter. For instance, the progress of expenditure had been very remarkable. In 1857-8, it was Rx. 39,570,000 in 1873-4, Rx. 58,250,000; and in 1890-91, Rx. 82,250,000. That showed a very considerable rise and a more rapid rise of late, and that was chiefly explained by the figures of army expenditure. In 1856 it was Rx. 12,750,000; in 1873, Rx. 15,250,000; in 1890-91, it was Rx. 20,000,000; and was now nearly Rx. 22,000,000. He was surprised that so much space had been given to an interesting but laboured account of what had been done with regard to defences. That was an explanation of the great outlay in excess of India's resources; and Sir William had insinuated rather than boldly affirmed, that there was excuse for that expenditure. But he would venture to say that that expenditure had proceeded, in a large manner, on a delusion, which could not be maintained had it not been for official secrecy; so that the people of England did not know what was going on. It was an extravagant and profligate expenditure against a merely possible and remote, but, in a military sense, utterly ineffective and puny, enemy and was one of the most damaging charges which could be brought against those who had administered India during the last 15 years. With regard to the drift of the paper, a tenacious logician might say that, seeing that all this prosperity had followed the Mutiny, why should we not have another mutiny? He thought this indicated a serious flaw in the argument, and that the author had very ingeniously deepened the colours of the former period, in order to heighten the effect of what had mainly been natural progress. He was very sorry also, to see that, after all that had been written

.nd was now known, Sir William Hunter had again ntroduced an apology for Lord Dalhousie's policy. Ie was a good administrator, but as a politician, nd one in charge of the future of India, he was one of the most disastrous Viceroys who ever went there.

Sir GEORGE BIRDWOOD, K.C.I E., C.S.I., said hat, at so advanced an hour, he would add nothing to he discussion calculated to delay the reply Sir William Iunter would himself make to his critics ; and he ose simply to propose the vote of thanks to Sir W. Wilson Hunter Sir Frank Forbes Adams would put o the meeting, and which he felt certain every one n the room would second by acclamation. Sir V. Wilson Hunter was one of the very highest ving authorities on Indian historical and adminisrative subjects, and always treated them with a disinction of style in which he was unapproachable y any of his contemporaries. His present paper was ull of the most valuable information, never before nade accessible to the public, and was indeed nothing ess than a new and most important chapter added o our knowledge of modern India. Everyone would ecognise the logical force, the literary tact, and the ramatic effect with which he had dealt with the acts, the bulk of them downright dry statistics, narshalled in his paper; and it was a great honour o the Indian Section of the Society of Arts, and one hey would all cordially appreciate, that a writer of Sir Wilson Hunter's position and reputation should ave devoted his rare stores of information, and still arer ability, and so much of his invaluable time, to he service of this Society.

The CHAIRMAN, in putting the resolution, wished o say how very thoroughly he appreciated this exeedingly able and impartial paper. It was evident, luring the discussion, that there were certain points pon which they were not altogether agreed, but e was perfectly sure that every one was of ne mind in passing a cordial vote of thanks o Sir William Hunter. He (the Chairman) was ot an official, and during 17 years of Indian exerience he often found himself opposed to the official iew, but he had had many opportunities during his ndian career of watching the working of the Civil Service in all its departments, and he did not hesitate o say that a more splendid service and a purer service ad never existed in the world, or one more anxious o promote the best interests of the people. He did ot mean that there were no faults, but had they ever nown so large a service which did not occasionally fail n attaining to perfect work? Sir William Wedderburn aid great stress on the importance of making the rinces and people of India loyal; he believed they were oyal, and the loyalty of the princes and people made all the more important that we should take care hat their property and posessions were fully protected om outside attack. With regard to frontier defence, e believed the money had been well spent, but he oped the day was coming when the expenditure night be very much cut down, for the finances of India could not stand the strain. He knew the temptation was to go on and on, but he hoped the Government would see the possibility, with the approval of the Secretary of State, of doing much to prevent the further growth of expenditure, and if possible of reducing it. Another point he would lay stress upon was the remark which fell from Mr. Hyndman, that the well-being of our fellow-subjects was our well-being. Was there a single man in that room who would not re-echo that sentiment? There might be a difference of opinion how that should be effected, but that every one heartily wished the well-being of the people of India he was postiively certain, and he thought the facts and figures in Sir W. Hunter's paper pointed to no little amount of past success on the part of Indian administrators. With regard to the condition of the people, there might be 30,000,000 or 40,000,000 who lived on one meal of millet a day, but, under the peculiar circumstances of their lives, they were comparatively contented. He hoped they all wished to improve that condition; and taking the whole 280,000,000 in India, they had materially improved their condition in the past 30 years, and they hoped yet to see it still go on improving until that 30,000,000 became 20,000,000, and ultimately disappeared altogether, and they could see the whole of the people comfortably provided for. But this would be brought about more by the action and efforts of the people themselves than by government. He was glad the Imperial Institute had been referred to, and if any words he could say there would induce anyone to join it, and do what he could to aid in its success, he should be extremely gratified. He thought the Imperial Institute might be made hereafter of very great use in bringing the people of all countries of the world to a thorough knowledge of the products of India.

The resolution having been carried,

Sir WILLIAM HUNTER, in reply, said he had listened with extreme interest to the discussion which had taken place. He should not refer to anything said by those who agreed with him, but would prefer to say a few words on one or two objections which had been taken. He spoke as a non-official; he had no official interest in British or Indian politics, for he had been entirely dissociated from the government of India for the last five years. Those years he had devoted to a careful and impartial study of Indian questions, and what he had now spoken was not with a view of drawing any optimistic picture, but to faithfully state what had been done in India during the last 25 years. Amid the various opinions which had been expressed, he had not heard one of his statements contradicted. He had not said that this prosperity, which was almost without parallel in history, was the product of the Civil Service, or of the military service, or of the Government. He had said that, since the rule had passed from the Company to the Crown, a state of things had been called into

existence which had produced a new industrial era, a new moral era, and a new political era, and brought about an entire revolution for the good of the country. With reference to Sir William Wedderburn's speech, he could not, of course, refer to political matters. Sir William Wedderburn said that our answer to Russia should be a loyal people. Well, our answer to Russia had been made by a loyal people. What happened after Pendjeh? Long before we could make any frontier defences, the people of India had themselves made the answer to Russia. The natives of the British Provinces came forward, and asked to be enrolled as volunteers. The Native States placed their whole armies at our disposal, and, at their own cost, offered to provide both men and means of transport. Such an answer was never made by a country under an alien rule before in the history of the world. Another important point made by Sir William Wedderburn, and in which he agreed with him, was that the revision which took place under the Company every thirty years was a very desirable revision. But what took place now? The affairs of India were not brought before Parliament once in thirty years, but every month, every week, every night. The scrutiny, instead of being occasional, was continuous. Of course, a continuous scrutiny could not cover the whole area in any one debate, but never before were so many columns of Hansard devoted to India as was the case at present. There was a continuous scrutiny, with a responsible Secretary of State, and Under Secretary of State, to deal steadily and continuously with Indian questions in Parliament. The Indian grievances which existed 35 years ago could not exist now for a month without ministers, both in the House of Lords and Commons, being made to answer for them. With regard to the great question of the poverty of India, he very much sympathised with what Mr. Hyndman had said. He himself pointed out, many years ago, that there were 40,000,000 of people just on the margin of subsisting. He was then an official, and, if influenced by optimistic motives, he should have been influenced then and not now. He believed then, that if the attention of the Government were drawn to the fact, efforts would be made to remedy the condition of the people. But how did he discover that number of 40,000,000? He went to the Famine Commission Report, and found that a certain proportion of the population—between 10,000,000 and 15,000,000 of peasant households — were struggling to live off about two acres each, and, allowing four to a household, that gave 40,000,000 living off an insufficient average of soil. He had candidly pointed out, that nothing could be done by spasmodic relief to affect the unhappy condition of these people. But he must add that, in analysing the poverty of this distressed population, he found out how it was they became so poor, viz., that families which, two or three generations ago, had sufficient land to maintain them, had now multiplied into three or four families, and divided the land, which formerly was sufficient, so that now there was an insufficiency. In the old times, population was kept down by the sword, by famine, and by pestilence. We had put an end to deaths by the sword in India, and we were struggling to counteract famine. But, as regards the intensity of famine, what had been the famines in this century compared with the famines of the past? During the last 30 years they had numbered almost every death, and there were about 2,000,000 deaths in one famine; but in the last century not 2,000,000 out of 100,000,000 but one-third of the whole population of Bengal went down under the earth in one famine, and one-third of the whole acreage went out of cultivation. The facts were recorded again and again by one witness after another. He was taking no optimistic view, but thank God, what we had done had been sufficient to make famine, in the old sense of the word, utterly impossible. When he was employed in the Orissa famine of 1866, he went about trying to feed the people, getting them to move out of the villages, to come to centres where they could get food. But their reply was that it was a true famine; what could the Government do, it was merely watering the top of a tree whose roots were cut. After that time, for the first time in the history of India, Lord Lawrence passed a resolution that the district officers should be held personally responsible for any unnecessary deaths by famine. Such an idea had never entered the head of any previous government of India. These 40,000,000 of people without food were the result of a system which we were powerless to alter. When the Hindoo arrived at 12 or 13 years of age, and the Mohammedan at 15 to 17, without any respect to the means of subsistence, they married—the Hindoos as a matter of religious obligation. In what country of Europe could such a state of things exist without widespread and hopeless poverty? You could not defy the economic laws and evade the results. The problem of poverty in India rested, to a large extent, with the people themselves. It was only by indirect influence, by education, and by a general advance of Western ideas and standards, that the increase of population, independent of increased means of subsistence, would ever be overcome. The Government might do something, but all that it could do was far less than what he hoped would be accomplished within a generation or two by the natives themselves. Mr. Hyndman spoke about the drain from India as being greater than Rome ever drew from Sicily. He supposed they had all read the Verrine orations of Cicero, and what was it that was complained of? What did the pro-consuls take back to Rome from Sicily? They took back bribes and plunder. But what did we send to India and what did we take back from India? We sent railway material, irrigation material, and military material which was absolutely necessary for the defence of the people. Our drain from India was not the drain from Sicily by Rome—bribes, pictures, statues, and plunder; but we sent to India money to construct public works, and charged

for that money less interest than ever an Asiatic country paid. He did not think India could do it cheaper with any other capitalist than England. One gentleman said India ought not to be utilised to supply offices for the well-to-do classes in England. What he had tried to show was that under the Crown a system had developed of employing natives themselves in their own administration, and had quoted statistics to prove this. He had mentioned that a law had been passed preventing any Englishman taking any salary in India above 200 Rs. a month, unless a member of the Staff Corps or Covenanted Civil Service. He hoped, when that gentleman considered the matter more carefully, he would see that the object was not to provide offices for Englishmen in India. From the first he had advocated largely the employment of natives of India, and not alone from a sense of justice, but also because he believed it was a very bad policy to have a large number of Europeans in India growing up with children, and attempting to settle in the country. For the present, Europeans must have the control and supervision, but they did not wish to take the work of administration out of the hands of the natives, but to share it with them. Mr. Martin Wood said that the defence of India depended on the loyalty of the people. But in no country does the national defence depend solely upon the loyalty of the people. They could not in England depend on the loyalty of the people without troops, and without a navy. It was utterly impossible to trust to loyalty alone; loyalty must be armed; and never before in the history of British India had a Government felt so sure of the loyalty of the people as to put arms of precision into the hands of the troops of native princes as it now does. He yielded to no one in a desire for the benefit of the Indian people, and he was very glad that the Chairman had so arranged the discussion as not to bring forward anything in defence of what he had said, because he wanted to hear what could be said against it. After having passed over 30 years in the country as a supposed philo-native, as a man whose career in India had been devoted to the advancement of the natives of India in education, it was somewhat of a surprise to him to find himself regarded as an optimistic official by several gentlemen present—gentlemen whose names had not, in some cases, been associated, so far as he knew, with any practical work for the people of India.

ELEVENTH ORDINARY MEETING.

Wednesday, Feb. 22, 1893; The Hon. SIR CHARLES FREMANTLE, K.C.B., in the chair.

The following candidates were proposed for election as members of the Society:—

Bristow, George Ledgard, 1, Copthall-buildingss, E.C., and 2, Cedars-road, Clapham-common.
Paramor, John, Rickmansworth, Herts.
Tucker, James M., 12, Great Tower-street, E.C.

The following candidate was balloted for and duly elected a member of the Society:—

Dayol, Roberto, Mexico City, Mexico.

The paper read was—

OLD AGE PENSIONS AND THE STATE.

By T. MACKAY.

Ought old age to be a public or a private charge? That is the issue which the country is being asked to try.

The principle at stake is one of far reaching importance. If it is desirable to relieve the inhabitants of this country of responsibility for providing the necessaries of life in their old age, it is obvious that the same principle may be extended to other risks of life. A certain section of the advocates of a State pension admit this, and indeed base their advocacy on this very ground. They conscientiously believe in the possibility of Socialism. They desire to see the functions of the State gradually enlarged till at length they absorb all the activities of our social life. They look forward to what they term a complete "Socialisation" of all the instruments of production, and to a time when the whole population shall be first the salaried, and then the pensioned servants of a vast bureaucracy. To make the State responsible for the maintenance of old age, is to them, therefore, only one step in a much larger revolution. It is not my intention to dwell on this aspect of the question, though, it seems to me, to be the only logical position which can be taken up by those who desire to make a public provision for old age, otherwise than is already provided by our Poor-law. I content myself by remarking that, for the present, the difficulty of this view appears to me to be considerable, for though, up to a certain point, a well-organised government might discharge the responsibilities of mankind, as these are at present estimated, no government can remove from individual men their power of creating responsibility. By responsibility, I mean, of course, such things as marriage, and the consequent demands of wife and family, the hunger arising from the consumption on Monday of the supplies which, by careful husbandry, should have lasted till Saturday. The creation of such responsibility is at present held in check by the knowledge that he who creates must also discharge. If this condition be removed, first in one, and then in another direction, it will appear to plain men that we are within sight of a speedy dissolution of society.

But I am well aware that there are many advocates of State pensions who do not take

this extreme view, who think it possible to limit the extension of the principle to old age, and that thus limited, the removal of the responsibility from the individual to the State will be a salutary change. The view cf these, the more influential, but as I venture to think less logical, supporters of the State Pension Policy, can be gathered most conveniently by a brief history of this agitation.

It began with Canon Blackley. He observed that a great many people, in their old age, became destitute, and a charge on the rates. He was of opinion that many, or all of them, ought to have been able to provide for themselves. He, at first, at all events, insisted that old age was a private charge, and of so paramount a nature did he consider it, that the law, he argued, should be called into operation to force men to discharge their duty in this respect. His proposal, therefore, was, that before reaching a certain age, everyone should be compelled to deposit with a public department a sum of money sufficient to provide him with a pension in old age. A Parliamentary committee considered this, and a kindred proposal for compulsory sick insurance, and reported that they were not practicable. Their author has so far accepted this verdict that, for the time being, he has joined himself to the supporters of a different proposal, generally known as Mr. Chamberlain's proposal.

This scheme abandons at once the view of Mr. Blackley, that the maintenance of old age is a strictly private charge. It is proposed by an informal Parliamentary committee, over which Mr. Chamberlain presided, to pay a subsidy out of the rates and taxes of the country, to assist people to buy deferred annuities. As I understand it, Mr. Chamberlain sees no objection, in principle, to making his insurance scheme compulsory; but, practically, all parties seem for the present agreed that compulsion is not possible. The argument, I take it, is as follows:—It is not possible, as Canon Blackley has proposed, to compel a man "to be kind to his old age;" but, if a public insurance department holds out an offer of paying (say) 40s. for each £1 subscribed, the unwillingness and inability of the submerged classes to join in this form of investment will be removed.

At this point the question is taken up by Mr. Charles Booth and his supporters. They point out that, unless the provision for old age is in some way made universal, it will leave untouched the very class in whose interest this agitation has been raised. If the so-called submerged class will not subscribe to a sick club, by which they become entitled to a[n] immediate benefit in event of sickness, it i[s] not likely they will be induced to subscribe fo[r] a benefit which will not become due for 4[0] years, which many of them may never live t[o] enjoy. Mr. Chamberlain's new insurance polic[y] might be taken up by well-to-do members o[f] of the middle class, but, in all probability, no[t] at all by the lowest stratum of society.

Mr. Booth, therefore, carries the evolutio[n] of the pension theory a step further, and pro[-] poses a universal endowment of old age, t[o] the extent of 5s. per week. It is impossibl[e] he urges, in effect, to enforce subscription t[o] an insurance fund; it is useless to subsidise the only way in which our benevolent inter[-] tions can be carried out is by endowing eve[ry] man, when he reaches 65, with a statutor[y] right to an allowance of 5s. per week. To ex[-] tend this advantage to England and Wale[s] without any cost of administration, will ad[d] Mr. Booth calculates, a sum of £17,000,00[0] per annum to our national expenditure. Th[e] cost of this propcsal, which for the Unite[d] Kingdom would probably not be less tha[n] £30,000,000 per annum, has frightened som[e] of Mr. Booth's most competent allies.

Mr. T. E. Young and Mr. R. P. Hard[y] are well-known actuaries. They regard M[r.] Chamberlain's scheme as unworkable on a[n] actuarial basis, and they approve of the phila[n-] thropic principle which, they conceive, unde[r-] lies Mr. Booth's universal endowment, b[ut] they recoil from the expense which it involve[s.] They add, therefore, a condition of their ow[n] to this effect: no one is to have the benefit [of] Mr. Booth's endowment, unless they are pe[r-] sons of good character, and actually in wa[nt.] Mr. Booth has also made a concession in th[is] direction. One of the last additions to h[is] plan is a proposal to exclude from pension tho[se] who have been in receipt of Poor-law rel[ief] within ten years of reaching the age of 65. M[r.] Booth insists throughout that the question [of] inclusion or exclusion must not be left to t[he] haphazard discrimination of a board. At fir[st] he was in favour of universal inclusion—[no] one was to be excluded—and now the o[nly] exclusion he will sanction is an exclusion th[at] shall be determined automatically, and not [by] the fiat of any board or committee. This co[n-] dition has separated Mr. Booth from anoth[er] of his supporters—Mr. Frome Wilkinson. A[n] article by this gentleman, in the Janua[ry] number of the *New Review*, brings us ba[ck] to the *status quo ante* by proposing th[at] guardians shall give every old person an allo-

ınce of 4s. or 5s. a week out-relief. This last ıroposal is not a proposal for pensions, but for ı wider extension of the facilities for entering he ranks of pauperism throughout the country. The circle is thus complete. We start from he Poor-law and we return to the Poor-law.

I have dwelt on this boxing of the compass ıf opinion, because it seems to me to show that he State pension party has not quite made up ts mind as to the grounds on which it asks ıs to make a very considerable change in our ocial arrangements. In truth there are several ›tate pension parties, and their opinions are nutually destructive the one of the other. In ›olite controversy one must always assume hat opponents have carefully thought out the ›earings of their position. I gladly extend his courtesy of debate to our State pension riends, for I think it entitles me to remark hat if these distinguished gentlemen were to e locked up like a jury they would starve ather than agree upon a verdict.

We must examine these proposals in some etail. Canon Blackley's scheme need not etain us long; it is left derelict by its author, nd I hear no one else is likely to adopt this rphan. If any one doubts the wisdom of this bandonment, I would ask him to attend a ıeeting of unemployed on Tower-hill, and then ɔ explain to us how he proposes to get a deposit f £10, or whatever the sum may be, from the ıany young fellows who are there agitating ıeir grievances, or from the young men of the lass there represented.

Though I do not believe that Canon ›lackley's scheme is either desirable or prac- cable, as an amateur in social panaceas, I ery much regret that Canon Blackley has bandoned his very original contention that very man should provide for his own old age. t gave his scheme an air of Athanasian bold- ess and a value altogether unique in the istory of latter-day "movements."

While on this question of compulsion, I may e permitted to point out that though it may ot be possible to compel men by law to dis- harge the duty of providing for old age, there et remains, though we have nearly legislated out of existence, a certain amount of natural ompulsion urging a man in that direction. here is an old maxim of the Poor-law, that it ; undesirable to make the condition of the auper superior to that of the independent bourer. The maxim has been largely dis- garded, as far as old age is concerned, by ıose who are responsible for Poor-law ad- inistration. Everywhere, with only a few exceptions, the aged and improvident person has been given relief at his own home, and thus put in a superior position to the independent aged person, who has been obliged to practise much self-denial in order to preserve his inde- pendence. When this is the condition of the law, it is not to be wondered, if a large number of the poorer classes regard their old age as a thing to be provided for by the law. Over a considerable part of England that is the view taken, not only by the poor, who cannot be blamed for their attitude, but by the administra- tors of the law.

Guardians sometimes talk as if they were proud of the number of poor people who have been induced to rely on this provision for their old age. I am afraid, however, that in the rural districts a more selfish motive is often at the bottom of their action. The knowledge that a lavish system of out-relief reduces the farmer's labour bill has had its influence in this matter. If the employer can get old men and widows, partially supported by the rates, to do even a portion of his work for him, he is able to keep down the rate of wages for able- bodied men.

This aspect of the question is important, for, if we sympathise, as I have no doubt many of us do, with Canon Blackley, in his desire to see every man meeting his own responsibilities, we cannot, I think, avoid the conclusion that the independence of the poor in old age is to be achieved, not by the artificial compulsion which Canon Blackley himself admits to be impracticable, but by that natural compulsion which urges all men to habits of self-preserva- tion. If such be our view, it is obvious how closely this problem is interwoven with the administration of the Poor-law. If we must rely on compulsion, the only practicable form of compulsion is a natural compulsion. This natural instinct of self-preservation exists in every man's breast, ready to urge him along the path of social and economic virtue, if we do not defeat its power by a lavish and ill-con- sidered administration of the Poor-law.

To pass to the next phase of the question, viz., to the proposal for assisted insurance against old age. Now the difficulties of the poor are very numerous; old age is not the only risk which they have to meet; and I have never been able to understand why these philanthropic gentlemen have fixed on this one particular risk, old age after 65, as the one which they are going to subsidise. Is it quite certain that old age is the most pitiable and helpless condition of mankind? In such a matter as

this, the practice of boards of guardians is a very fair test of the average opinion of the world. Now, there are some boards of guardians which give out-relief to widows with children but refuse it to the aged, on the ground that the destitute condition of a widow is more helpless and involuntary than that of persons who presumably have had 40 years of working life, and, therefore, some opportunity to prepare for the inevitable approach of old age.

Again, one asks, why fix on 65 as the age at which a man is entitled to become partially dependent on the rates and taxes. There are no official statistics available to show what proportion of old-age paupers over 65 have been paupers from an earlier period of life; but it would appear, from a calculation made by Mr. Loch, on figures supplied by the relieving-officer of Stepney to Mr. C. Booth, that, of the paupers over 65 in the Union of Stepney, very nearly one-half—44 per cent., in fact—became chargeable before they reached the age of 65. (Loch: "Poor-law Conference Papers," No. 3, for 1892.) It is obvious, therefore, that the proposed subsidy, even if accepted largely by the poor, would not abolish old age pauperism. Moreover, it is not possible for one moment to contend that it would be accepted largely by the present pauper class. It is probable that the annuities—if, by reason of gratuitous subsidies, they were made what is called in the city "good things"—would be taken up by the prudent investing middle class, as, indeed, has been the case in France and other foreign countries, where subsidised deferred annuities exist. As far as the submerged are concerned, the result would inevitably be disappointment; indeed, the whole proposal shows, I venture to think, some ignorance or disregard of the condition of the class which these insurance proposals are intended to benefit.

The pauper class in this country is very much what the Poor-law has made it. I am not going to say that they are a vicious class, or that they are less "deserving," to use a question begging phrase, than their more fortunate neighbours. For my own part, I believe, that all men are equally undeserving, but I do affirm, and that without any fear of contradiction, that the pauper class is an irresponsible class. To this point, however, I propose to return. I only here wish to say that everyone who has any practical knowledge of the subject will agree with Mr. Booth, and the other critics of Mr. Chamberlain's scheme, that no amount of gratuity short of a free gift will have any influence whatsoever on this class, in the way of inducing them to subscribe for deferre annuities. Old age is not the risk which th responsible poor find it most difficult to mee and the proposed insurance will have abso lutely no effect on the irresponsible.

The next point with regard to this schem to which I wish to draw your attention, is th nature of the investment which it seeks t popularise. It is a proposal to subsidise, no all forms of saving, but only the purchase o a deferred annuity. Now if the choice of ol age as the risk of life to be made a charge o the rates seemed to us an arbitrary choic what shall we say of the selection of this on particular instrument of meeting it?

It is extremely probable that there is not single person in this room who began at th age of 25 to purchase an annuity to becom payable at the age of 65. The Post-office ha most elaborate arrangements for facilitatin the purchase of deferred annuities. They hav been a complete failure. From April 17th 1865, to December 31st, 1889, 540 contrac were opened for deferred annuities, money no returnable; and 1,067 money returnable (se 37th Report of Postmaster-General); and wit regard to these last, the money returnable very often returned, and the contract is no persevered in as a deferred annuity.

The great Friendly Societies, the Foreste and the Manchester Unity of Odd Fellow started schemes of old age pensions on th principle; after some years' trial it was foun that only three or four had availed themselv of the facilities offered. Mr. Bartley, the suc cessful manager of the National Penny Ban wrote some time ago, in the *Standard*, th he does not remember to have come across single instance of a man saving by means a deferred annuity. I had the advantage discussing this question with Miss Octav Hill some little time ago. She could not ca to mind a single instance of a deferred annui purchaser. She knew a great many peop who were in the habit of saving in vario ways; some put money in banks, others, u skilled labourers perhaps, made sacrifice, an brought up their children to a trade. She fe strongly the impertinence involved in pryin into these poor people's affairs, and she on knew what they chose to tell her; but sh knew enough about them to give her eve reason to hope that those people who we really in earnest about saving would not com upon the parish in their old age. I cou multiply such evidence as this indefinitely. will add one small item of official evidence.

The statement is often made that the friendly ociety man is very frequently forced to come n the rates in his old age. If this really is so, t might seem to throw some discredit on the iew expressed by Miss Hill, for the member f a genuine friendly society is emphatically a erson in earnest about saving. But what are he facts. A certain Parliamentary return, nown as Lord Lymington's return, professes o give the number of persons in workhouses vho declare that at some period of their life hey have been members of some sort of proident society. The list does not exclude memers of the Christmas sharing-out club, or perons who have been a few weeks in some ublican's goose club, and the figures are vithout doubt largely exaggerated and cerainly unverified, yet the late Chief-Registrar nforms us that the return for 1881 only shows proportion of 1 indoor pauper to every 354 of he adult membership of the friendly society, or f the calculation is based, as it should be, on he number of those who attributed their auperism to the breaking up of their club, he tale of indoor paupers did not amount to 1 n 1,000, a striking proof, I venture to think, of he substantial accuracy of Miss Hill's remark.* Even if we make a very liberal allowance for he number of Friendly Society members receivng out-relief, I think we may safely assume hat the proportion of genuine friendly society nembers who become paupers is very small. The people who become paupers are those rresponsible beings who carefully avoid the riendly society and all its works.

Mr. Brabrook, the Chief - Registrar of Friendly Societies, told the Labour Commision that his department had cognisance of ver £200,000,000 sterling, representing for he most part savings of the working-class.

I have made a rough calcluation, from the ast Statistical Abstract and other available ources, as to the more obvious institutions vhere working-class savings are deposited.

I find that, of a total of £220,000,000, only bout £31,000,000 are earmarked for one paricular purpose. The rest is free, and available o be used for old age or any other incident that may arise. Of these £31,000,000, £20,000,000 belong to the Friendly Societies, which, in many cases, do make an allowance in old age.

Present Ttme, say 1891.

	£	£
*Post-office Savings Bank, 1891	71,608,000	
*Trustee Savings Bank, 1891	42,875,000	
*Government stock standing in name of depositors at Post-office, 1891	5,087,000	
*Government stock standing in name of depositors at Trustee Banks, 1891	1,282,000	120,832,000
*Building Societies, 1890		52,482,000
*Industrial and Provident (Co-operative) Societies, 1890		15,261,000
*Industrial Insurance Companies, 1890	8,873,000	
†Friendly Societies	20,167,000	
‡Collecting Friendly Societies, 1889	2,565,000	31,605,000
		220,180,000

In order that some idea may be given of the rate at which these investments are growing, I have made out a second list, showing the state of affairs during the past 15 years :—

	£	£
*Post-office Savings Bank, 1877	28,740,000	
*Trustee Savings Bank, 1877	44,238,000	
*Government stock standing in name of depositors at Post-office, 1881 (no earlier figures given)	738,000	
*Government Stock standing in name of depositors at Trustee Banks, 1881 (no earlier dates given).	124,000	
		73,840,000
*Building Societies, 1876.		20,854,000
*Industrial and Provident (Co-operative) Societies, 1876		6,224,000
*Industrial Insurance Companies, 1880 (no earlier figures given)		1,476,000
Friendly Societies, 1876 (as estimated by Mr. Ludlow, "Chief Registrar's Report," 1890, Part A., p. 9)		9,336,000
		111,730,000

These figures give you a very fair indication of what the humbler classes of society have

* A similar return hasbeen made for 1891. There were at hat date 14,808 indoor paupers who alleged that they had een members of some provident society, of these 10,215 had eased to be members by non-payment, withdrawal, or disissal, the remainder 4,593 by the breaking up of the societies. here is nothing, however, to show that these "break ups" ere anything more than the yearly dissolution of the rdinary sharing-out clubs. The membership of friendly ocieties is stated by Mr. Radley to have been in 1886, 700,000.

* Statistical Abstract, 1877 to 1891, 39th number.

† Rev. T. Frome Wilkinson, "Mutual Thrift." Estimated, p. 191.

‡ Rev. T. Frome Wilkinson, "Mutual Thrift," p. 194.

been doing with their savings during the last 15 years. Probably not more than a few thousands have been devoted to deferred annuities.

Mr. Chamberlain and his friends very soon were confronted with this difficulty, that no reasonable man of his own accord ever began at the age of 25 to put money away beyond his control which would be lost to him entirely if he did not survive to 65. A reasonable man may see fit to insure himself against the uncertain risk of excessive sickness and premature death, but the risk of old age is of a totally different nature. When a man has insured against sickness and death, he very naturally says to himself, "I cannot afford to ear-mark any more of my savings, certainly not, at all events for a fund which I may never live to enjoy, in which my widow and family cannot participate. Rather than do this I will save what I can; possibly I shall have a chance of investing it in a profitable business. I will take a share or shares in a co-operative society, I will buy a house through a building society. I will subscribe for an endowment policy of insurance, to become due at death or on my reaching a given age, and if when I reach the age at which it becomes due, I am a lone man with no one dependent on me, I will consider whether I will not buy an immediate annuity. Generally I will bring up my family well, see that the boys are put into trades, and in other ways do what I can to consolidate and improve my position in life. The risk of a destitute old age, if I am spared health and strength to carry out even a part of these plans, does not disturb me. If I am not spared, my little savings will go to those I love, and I shall die thankful that I have not been selfish enough to waste my money on one of these absurd deferred annuities."

Such a view of the question is obvious enough, and after a period it made itself felt in the voluntary Parliamentary committee, and necessitated a change of front.

At first it had been proposed to pay a benefit in old age only. This, as we have seen, would not do; it was, therefore, determined to make the scheme more acceptable by adding a variety of multifarious benefits to widows and children and nearest representatives. This change threw the whole scheme into inextricable confusion, from which, as far as I can make out, it has never emerged. Let me explain.

It is an easy task for an actuary to draw up a set of tables for deferred annuities, but it is, I believe, an impossible task for any one to calculate the liability incurred by an institutio which contracts to give not only an allowanc in old age, but in addition to give an allowanc during a more or less lengthened period t widows and children (if any). This is nc insurance, but a proposal to establish a chari able fund. It is the essence of insurance th each insurer shall pay a premium carefull calculated to cover the risk which he insure To insure a man, and possibly his widow, a well as an indeterminate number of childre yet unborn, in this wholesale manner, for or inclusive capitation fee, is manifestly inequi able to unmarried men and to men with sma families, and imports into the contract a element of speculation altogether at varianc with common sense and sound economic progress.

In the earlier stages of the deliberations the informal Parliamentary committee the were frequent references to the labours of tl committee's actuary, but I notice that the subsequent utterances contain no reference t this gentleman, for whose difficult position w must all feel much sympathy. Actuaries, hov ever, have given opinions on this proposal; as specimen, here is what Mr. T. E. Young, a Vic President of the Society of Actuaries, says the matter:—

"I am confident, looking to the want of existing ar appropriate data, that the incorporation of the eleme of a pension allowance to widows and children essentially of the nature of guess-work. . . . . It m safely be affirmed that the scheme is doomed failure."

To sum up then, the objections which we hav taken to this proposal of assisted deferre annuities—

(1) There is no principle in selecting old ag at 65, as the estate of life to which state sul sidy is to be given.

(2) Nearly half the old age pauperism of th country probably commences before 65.

(3) The proposed scheme will not touch tl lowest class of the population.

(4) The method of deferred annuities is nc that which commends itself to the good sens of the labouring population.

(5) The attempt to meet this objection b throwing in a number of additional benefits not business, and deprives the fund of an claim to be called insurance.

One last objection which I have not notice though practically it is of more importanc than all others, is that the scheme is oppose unanimously by the Friendly Society interes

[r. Chamberlain and the other promoters have dmitted that if the Friendly Societies con- inue their opposition, this measure can never e carried.

I will give one brief quotation from the lead- ıg organ of the Manchester Unity of Odd- ellows. It deals with the specious proposal ıat the Government subsidy should be paid ırough the friendly societies.

"No thought of Government or rate-provided ıbsidy must enter into the calculations of those who ould lead the Order along the path which ends in ıperannuation. No sane person could imagine that ssistance or subvention would be given, unless ccompanied by inspection, and a proportionate ıeasure of control. This would prove a death-blow) the principles on which the Unity has reared itself) its present proud position, viz.—self-help and ıdependence. When interference enters the door, ıdependence will fly out of the window, and the ecadence of the Manchester Unity will have com- ıenced."

The late Mr. C. J. Radley was High Chief anger of the Ancient Order of Foresters in ugust, 1891, and in the course of his presi- ential address used the following words :—

"If it be proposed to create a system of State ıbsidy, open to all, then the plan is one for the re- acement of individual effort by State aid, without ıy need for it in the great majority of cases. If, ı the other hand, unsolicited assistance is to be ven to certain classes of the community, a distinc- on will be made invidious to those included, and ıjust to many of those excluded, which may go far supersede the teaching of our societies as to the dependence and equality of men. In any case, it ems a peculiar method of promoting the depauper- ation of the people, to keep a certain, or rather ıcertain, number of them off the rates for a few ars, by making a far larger proportion dependent ı subsidies from the taxes for nearly the whole of eir lives, and during the prime and vigour of man- ood."

I would beg you to note the words—*un- licited assistance.* The situation is a curious ıe. The philanthropists insist that the work- g-class shall partake of a dole from the rates. [r. Radley, a man who, in virtue of his office, was well entitled to speak on behalf of the labour- g class, on such a subject, as any other an in England, rejected the offer without esitation. "The assistance is unsolicited." et the agitation takes its course.

I am somewhat surprised to see that in his test contribution to this question, Mr. Cham- erlain has seen fit to make complaint in the llowing terms :—"Apparently, however, the ficials of the great societies have made up their minds to allow no other solution of the old age problem than one which is entirely in their own hands ;" and he goes on—"it seems a pity that the officials of these great and valuable organisations . . . . should warn off as intruders on their preserves the fellow- workers who are striving to increase the in- ducements to thrift."—*Nineteenth Century*, Nov., 1892.

Such criticism, I venture to think, is unjust. I do not think that the opposition of the Friendly Societies to Mr. Chamberlain's pro- posal can be attributed to such petty jealousy. Their aim and object is to maintain the absolute independence of their members at all periods of life ; and, as the quotation from Mr. Radley's speech amply shows, they—rightly or wrongly—regard Mr. Chamberlain's over- tures to them, not as the assistance of a fellow worker, but as an attempt to substitute a hybrid form of pauperism for that absolute and complete independence which they prize.*

Let us pass now to a consideration of the last of these proposals, the universal endow- ment of old age, advocated by Mr. Booth.

Mr. Booth proposes that every one who has not been chargeable to the poor-rate for ten years, shall, at the age or 65, become entitled to have 5s. a week.

The merits of this scheme are said to be—

1. That it will be instrumental in abolishing pauperism.

2. That it overcomes the difficulty of com- pelling the submerged classes of the com- munity.

3. That it will be an incentive to thrift, for the hope of receiving a gift of 5s. in old age will make it worth a man's while to save during his earlier life.

As to its influence on pauperism, if the figures already quoted from Stepney are at all representative of the rest of the country ; and, from inquiries I have made—and from what I

* I have in the text avoided any discussion of proposals for a revision of Poor-law methods for the relief of old age. I avail myself of a note to mention a Bill introduced into the last Parliament by Mr. Bartley, with a view of giving to the *provident* poor preferential terms of pauperism. Mr. Bartley's view of the subject involves two important ad- missions :—(1) That the relief of any class of persons from the rates is of the essence of Poor-law relief, and is not a pension ; (2) that "provident" is a term which cannot be confined to members of Friendly Societies, but must be ex- tended to all who have saved in any way whatsoever. A mere statement of this last proposition is sufficient to show the impracticable nature of the proposal. How is it possible to decide what portion of a man's possessions is the result of providence? A scheme to set a premium on inadequate saving can never afford a solution of this question. There is no half-way house between dependence and independence.

know of the strict administration of the law there and of the lax administration elsewhere —I am sure that the Stepney proportion is under rather than over the average, then, by one stroke of the pen, by the introduction of his 10-year limit, nearly one-half of our present pauperism is deprived of benefit under his scheme.

Again, will a pension of 5s. a week, even if it be paid weekly (some of the advocates of pension schemes urge quarterly payments, with a view of keeping down management charges), be effectual in keeping people off the rates? I recently discussed this proposition with one of the most experienced Poor-law officials in the kingdom, Mr. Vallance, the Clerk to the Guardians at Whitechapel. In the first place, he confirmed my conviction that a large proportion of the old-age paupers over 65 had been paupers before that age; secondly, he said he had been in consultation with the master and matron of the workhouse, and they had agreed that a very small proportion of the old persons under their charge would be kept out of the workhouse even if they had 5s. a week. This, I may say, was in a Union where no out-door relief is given, so this opinion covers all the old-age pauperism of the Union. A large number of them were friendless and infirm, and were perfectly comfortable in the workhouse; the rest were of that class that cannot go to sleep as long as they have any money in their pocket.

This, I believe, is a key to the whole problem — pauperism is not a question of poverty, but rather of habit and character. Time after time, those who observed these matters closely have seen two men starting life in exactly the same conditions, even among the very poorest class of agricultural labourers. One man will maintain his independence, and bring up his family respectably, the other will laugh at his responsibilities, and end his days as a pauper.

May I remind you of one of Charles Lamb's delightful papers—I hope the digression will be pardoned—for the point it illustrates is strictly relevant to our subject. "The human species," he says, "according to the best theory I can form of it, is composed of two distinct races—the men who borrow, and the men who lend. The borrowers are the *great race*. The lender is born degraded, 'he shall serve his brethren.' There is something in the air of one of this caste (the lender) lean and suspicious, contrasting with the open, trusting, generous manners the other. What contempt for money, accour ing it (yours and mine especially), no bett than dross."

These reflections recall to our author h friend, Ralph Bigod, Esq., a prince of bo rowers, fit to compare with the great borrowe of antiquity—Alcibiades, Falstaff, Sir Richa Steele, and "our late incomparable Brinsley "Ralph Bigod was, in youth, invested with amp revenue, and in borrowing had an undeniab way; mankind at large was his tributary. Li Cæsar Augustus, he ordered all to come up a be taxed. With such sources, it was a wond how he contrived to keep his treasury alwa empty. He managed it, however, by force of aphorism which he had often in his mouth th 'money kept longer than three days stink So he made use of it while it was fresh. good part he drank away (for he was a excellent toss pot); some he gave away; th rest he threw away . . . . out away from him must go, like Hagar's offspring, into the wild ness, while it was sweet. He never miss it; the streams were perennial which fed s fisc."

It is a picture to the life. Sad havoc th affable spendthrift must often have made poor Elia's slender store of guineas. Yet wi what delightful tolerant irony he delineates character.

It expresses to the letter what I have to s about the pauper. The pauper is your Ra Bigod, Esq., in humble life, and this is e reason that 5s. a week will not suffice to ke him off the rates.

His principal tributary is the Poor-law, t he will condescend at times to borrow of s neighbours. I am told, on excellent author, that the publicity given to saving by the po ing of a savings' bank book is much dread by the thrifty poor, because of the Ra Bigods of their acquaintance, and many f them have gladly availed themselves of y informant's permission to have their bak books sent to her private address.

We all have a sneaking affection for the Ralph Bigods, and I think middle-cl s philanthropists are mistaken in attributg excessive turpitude to the pauper class. Ty are, though in a humble way, members of e great race, and take their toll from a tributy Poor-law.

Another error we sometimes make is, t t we are inclined to attribute to the poor a excessive unhappiness in their poverty. I do not know that it is a matter for congratu tion or regret, but I think the poor have v y

:tle fear of poverty. Over and over again ıe has seen a poor widow spend the whole, · nearly the whole, of £10 or £20 insurance oney in funeral and mourning, although next ıy she was absolutely destitute, and obliged ı apply for Poor-law or charitable relief. To ve a particular instance of this happy-go-cky sort of disposition, if I may use the term ithout offence,—a clergyman, sometime ago, ld me of a woman who, as he believes, was ıtirely dependent on a temporary allowance ıid to her by him. At the time a small parish ιcursion was being organised, tickets 3s., &c.; ı my friend's surprise, this woman applied for ticket, and, on inquiry, he found that she felt ɜr poverty so lightly that she looked forward ı buying a happy day in the country with hat was practically the last shot in the ıcker.

One more illustration. Some 18 years ago ıtdoor relief was given in St. George-in-the ast, and just outside the relief-office there as a well-known public house, and on pay ıy there was a perpetual stream of paupers ırough its portals. The average allowance as in those days under 1s. per week per ıuper. I do not suggest that these people rank to excess, but I think the circumstance ıows that they estimated very lightly the .ct that this unnecessary expenditure would robably leave them very short of the bare neces-ıries of life towards the end of the week. The wner of this public house was an active mem-er of the Board, and one of the strongest pponents of the restriction or abolition of out-oor relief which took place at that time. He as actuated, no doubt, by motives of a pure ut, as I believe, mistaken philanthropy; still t the time it was freely admitted that the hange would mean to him a considerable ecuniary loss.

I trust that these anecdotes may not appear relevant; they seem to me to throw light on ıe nature of the character with which we ave to deal in our attempts to improve the ondition of the pauper.

An ingenious acquaintance of mine, lately ɜturned from the tropics, unfolded to me re-ɜntly a brand new plan for solving the problem f pauperism. "Emigration," he began. Ah, yes," I interrupted, "we have heard of ıat before, but paupers will not make good migrants, and people who can get on in the olonies can, as a rule, get on at home." My iend, however, was none of your ordinary anacea mongers. "Mine is not an ordinary migration scheme at all," he said. "I have come from a place where bananas grow wild; the native basks all day in the sun, and feeds on bananas. Now that is the climate we want for some of our failures at home. It is no good sending them to Canada, but we will set them down under those banana trees, and they will live happily ever after." Whether my friend is founding a society for the purpose of giving effect to his views, I do not know. I only mention the incident for the purpose of expressing my belief that our pauper class already have their banana trees in the shape of a tributary Poor-law and a philanthropic public. Consider the temptations to live down to an irresponsible level that lie in the path of an easy, jovial spirit, with a natural aptitude for playing the part of one of the great race. His children are educated for him; if he is sick, he can go to an admirable infirmary, or, if he prefers it, he can very often get relieved at his own home. If he dies, his wife will get the usual widows' allowance of out-door relief, he has no occasion to violate his favourite aphorism on her account; and when he grows old he can reckon with tolerable certainty on getting an allowance from the parish equal in amount to what can be saved by that lean suspicious race which he so justly despises. All this he gets from the law of the land, and if any of his remaining burdens are irksome to him, he can readily catch a tributary or two on the preserves of the philanthropic public.

These wild bananas, as I venture to call them (though they are not really wild, but in many cases raised on the privations of the poorer ratepayers) do not satisfy Mr. Booth. The out-door relief allowance in old age is not given with sufficient acclamation and applause, let it therefore be called a pension, and given to every one, whether he requires it or not.

This plan, Mr. Booth would have us believe, will be an encouragement to thrift. He speaks, and I am sure thinks, respectfully of the virtue of thrift, for he has not reached the point of view of the Continental Socialist, who declares himself "opposed to all institutions of thrift which merely encourage labourers to new privations," or who asks, "What is this doctrine of personal responsibility? It is economy, it is thrift, that is to say, a doctrine most absurd, for every economy is a crime."

Mr. Booth does not adopt this language, but surely he takes a strange method of showing his respect for the economic virtue of thrift, viz., by seeking to render it even less necessary than it is already.

Is it the experience of men of the world that

to give a man 5s. is an encouragement to him to save another 5s.? I have always been told on the contrary, that it is an encouragement to him to ask for the gift of a second 5s. when his occasions require it. As yet the poorer classes of the country have not solicited this assistance, but on the contrary, have strenuously protested against it. The politician, however, has been very busy in his offers of service; already, in the last Parliament, some of those who differ from Mr. Chamberlain about the Irish question, in order not to be outdone, have introduced Bills giving more liberal allowances than Mr. Chamberlain offered.

But the proposition that a pension will not necessarily keep a man out of the workhouse is not mere matter of theory; from inquiries that I have made from guardians here and elsewhere, I am able to say that there are a considerable number of army pensioners in workhouses. Their allowance is generally, I believe, 1s. 5d. per diem. If the guardians know of this pension, it is their duty to attach it. Some of these people are no doubt friendless and infirm, and find themselves most comfortable in the workhouse. As a rule, I understand their pensions more than pay for their maintenance, so that at the end of each quarter a balance is paid over to the pauper. Many of them go out and have a "good time" for a day or two, and then return to the workhouse.

In some instances, the guardians do not know of these pensions, and then the man gets his pension and his maintenance as well. I accidentally heard of one such case within the last few days.

These remarks refer to men in the body of the workhouse or infirmary; but, beyond this, it has always been a mystery to some of us to know what are the attractions of the casual ward. Possibly, this has something to do with it. There are in the casual wards every night a considerable number of ex-soldiers, pensioned or unpensioned; it is not possible to say how many, for the casual paupers go in and out of the wards without question; no one asks what their profession is, and there is, therefore, no danger of their pensions being attached. They, therefore, to use what I believe is a technical term, "tumble to" and adapt themselves to the life of a casual ward.

I had an interview with the superintendent of a London casual ward a few days ago. In answer to my inquiry, he told me that there were certainly a considerable number of army pensioners in the habit of coming to his wards. One, whose name he gave me, was in receipt of a pension of 2s. per diem. As quarter tim drew near, he heard in the wards talk an gossip on the subject, and, immediately aft the quarter day, there was a sensible diminu tion of the numbers in the wards.

Now, if 14s. or 9s. 11d. a week do not kee a man off the rates, what can we say abo 5s. a week? These facts, I confess, have onl recently come to my notice, and I do no know whether the pauperism of these per sioners can be proven to any very conside able extent; but I have learnt enough t tempt me to hazard the hypothesis that, t the character undisciplined in the habits o saving, and the frugal living which this nece sitates, these pensions, coming as a sort o windfall, are as likely to be an incentive of ri as of thrift.

My argument is, that pauperism is muc less a question of poverty than we general suppose. But what, some one will ask, is t be said about the agricultural labourer an his miserable wages? In the first place, question if the agricultural labourer is real so much worse off than his urban neighbour His nominal wages are low indeed, but he ha extra wages at harvest time; he has a cottag as a rule, at a less rent then the town laboure pays for a single room, and he has a garden and, in many cases, an allotment.

I was told, a few days ago, of a Shropshir labourer, receiving 15s. a week, who migrate to the town and got a situation, first at 18s and then at 22s. a week; but after some ex perience he voluntarily gave up his place an returned to 15s. a week as an agricultur labourer.

Still, wages in the country are low; but ar pensions any remedy for low wages? Let m quote to you what the Chief Registrar o Friendly Societies says in his Report of 1891:-

> I do not understand how any plan for relieving th working man of that which ought to be a charg upon his wages, can be other than a disadvantage t him, by leading him to refrain from claiming and en forcing his right to such wages as will enable him t meet the charge. It is for his Friendly Society t fix what he ought to pay, and for his trade union t see that he has the means of paying it. It is bett for the State, that is the general body of tax-payer that he should be paid suitable wages for such se vices as he renders, than that it should be made u to him for a deficiency of wages by doles of an kind."

There can, I think, be no doubt as to th justice of this view. A system of pension

ould certainly tend to reduce wages, and for ıe reason given by Mr. Brabrook. Whatever ew we take of the theory of wages, it is ›rtain that the standard of comfort aimed at / the labourer has much to do with the rate ' his remuneration. If a provision for old ;e is made no part of his standard of com- rt, his wages will tend to be proportionately wer. To supply to him, out of the rates, the ›cessaries of life which ought to form a por- ›n of his standard of comfort, is to condemn m to a permanence of inadequate wages. A ·incipal cause of low wages in the past has ›en the grants in aid of wages, sanctioned / the old Poor-law; a principal cause at the ·esent time is an administration of the Poor- w which deludes the labourer into resting ›ntent that his old age shall be supported / the rates, and not by the adequate wages which his manhood is entitled.

Those who have followed with attention recent ›ntroversies on Poor-law administration, will ›ar me out when I say that the most remark- ›le successes in rescuing populations from ıuperism have occurred not in towns, nor in aces where wages are exceptionally high, t in agricultural districts where low wages evail. I allude, of course, to such remark- ›le reformation as has taken place in the ral union of Bradfield. Poverty, alas, has t been eradicated, but a first step in that rection has been taken, independence has en restored. The pauperism of the union s been reduced from over 1,200 in 1871, to out 120 at the present time. And how has s been accomplished? not by any great rise wages, not by any systems of pensions, but resisting the beginnings of that irresponsi- ; spirit which is the cause of pauperism. edical relief, the first step in the descent to ; Avernus of pauperism, is not given except loan, and the borrower is not allowed to t himself in a better position than his more f-respecting neighbour. What is the re- lt? That no one now wants to borrow, and, h hardly an exception, every family in the ion is a member of a medical club. Further, t-relief is not given when the breadwinner of ; family is sick. What is the result? That ; breadwinners are members of Friendly cieties, and they and their families remain lependent.

And what has this reformation cost the poor ›abitants of Bradfield? I venture to say y little more than the price of a few pots of er, and in exchange they have gained, and ; gaining, disciplined habits of frugality and independence, which are the only sure foundations of future progress.

The problem of old age is not pressing at Bradfield. While the old pauperism over 60 in some 26 unions selected by Canon Blackley is 42 per cent. of the estimated population over 60, in Bradfield it is only 4 per cent. The disease is arrested in its early stages, and the problem will grow easier each succeeding year. And all this, mind you, despite the proverbial poverty of an agricultural union!

The cause of pauperism is not poverty, the cause of pauperism is State relief, more especially as it is adminstered in the form of out-door relief. We shall not get rid of pauperism by extending the sphere of State relief, as proposed in this pension scheme of Mr. Booth. On the contrary, its adoption would increase our pauperism, for as is often said, we can have exactly as many paupers as the country chooses to pay for.

In the last pages of the volume of "Life and Labour of the People," published in 1891, Mr. Booth stated that he was preparing to equip himself for a practical discussion of the Poor-law. This admission of inexperience in the practical work of administering relief is characteristic of Mr. Booth's candour. I read and noted it at the time, and I confess that I was somewhat surprised to see that, before the year was out, Mr. Booth had come forward with a stupendous scheme for the revolution of our Poor-law, involving an expenditure of not less than £30,000,000 a year. I trust it is not hypercritical to remark that the gravity of the matter in hand might have warranted a greater show of deliberation. One other consideration I ask leave to place before you.

There is probably no institution of which the working-classes and the country are more justly proud than the Friendly Society. It is a unique Anglo-Saxon institution, of purely working-class origin.

Now, if some Mr. Booth of 50 years ago had induced the Legislature to say that sickness was to be an honourable public charge, would these admirable institutions have ever reached their present splendid and impregnable position.

Who is it that will say thus far and no farther to the onward march of working-class independence? Is it utopian to believe that in resolutely grappling with the problem of old age there will be given to the wage earners of this country a new accession of strength and of resolute, independent character, which will

carry them forward along the path of progress. If this be our hope, we must summon up courage to say to the poorer classes of this country, "These are your responsibilities, do not let any specious counsels filch away from you your right to overcome them. They are the ladders by which you will rise to higher things."

It is very possible, as some tell us, that we shall be worse before we are better; the new ruling classes of this country must buy experience at some cost, but, in the long run, truth and common-sense will win; and, I do not believe that the working class is likely to ruin itself and the country, by proclaiming a universal cessation of personal responsibility.

In the meantime, we must have our Poor-law—it is an inevitable evil—but, to justify its existence, it must perpetually be making war on the irresponsibility which is the main cause of pauperism; it must, in fact, be so administered that it tends to throw the people more and more on their own resources, to diminish, and not increase, the number of those permanently dependent.

To insist on the view which I have endeavoured to present to you to-night, is, at the present day, an ungrateful and unpopular duty. All that I will say, in conclusion, is, that I shall be glad if I have succeeded in doing so without offence.

DISCUSSION.

Mr. E. W. Brabrook said he was thoroughly in agreement with the author of the paper. He was much struck the other day by receiving a report from the Ancient Order of Foresters, containing a table showing that, of their 600,000 members, there were about 3,000 of ages from 85 up to 99, which, he thought, on comparison with the general population, would show that the members of this body enjoyed exceptional longevity. The persons referred to were all in full connection with the order; they were not in workhouses; and this showed that this great society had, to a large extent, solved the question of providing for its members in old age, or, rather, was encouraging them to provide for themselves in a practical way. He was aware that the way in which they provided for it was not always the best way, and that it led the societies into responsibilities greater than the contributions provided for, thus contributing to the somewhat embarrassing condition which some of the courts were now in; but it was effectual to a large extent. It provided sick pay throughout the whole of life, though on a small scale, the amount, after the first year, being usually only about 2s. 6d. a-week. Of course, there must [...] other sources on which to depend, but there w[...] something in the mere fact of belonging to a friend[...] society which tended to keep a man in mental a[...] bodily health to a late period of life. He thoug[...] Mr. Mackay had quoted figures which underestimat[...] the number of those who had actually insured f[...] deferred annuities. In the Manchester Unity th[...] were not three or four, but several hundreds, if not [...] thousand. But that really was a small part [...] the question; a deferred annuity was only one fo[...] of providing for old age, and not the most appr[...]priate one in many cases. There was first the natu[...] way of bringing up children well, and dependi[...] partly on them, and there were many other wa[...] which the working-classes largely availed themsel[...] of. He was rather surprised lately to see a spee[...] by a right rev. prelate, in which he referred to t[...] wages paid as being wholly insufficient to enable m[...] to provide for old age. That seemed to him to be [...] most false view to take. Whatever the wages we[...] the men must provide for old age out of them, as the[...] was no other fund. Judging from statistics, he thoug[...] the members of friendly societies, on the averag[...] contributed about a week or a week and a half's wag[...] per annum; and if that were not enough they mu[...] pay a little more, as persons in other classes d[...] Whatever a man's income was, he should measure [...] demands and necessities accordingly.

Mr. Edgcombe said he only came in time to he[...] a part of the paper, that which referred to Mr. Bootl[...] scheme, as to which he would only say that it was [...] very large experiment, and that a very strong ca[...] ought to be made out for taking such a tremendo[...] leap in the dark. His small experience led him to t[...] conclusion that the scheme was quite unnecessary. [...] held that it was not those who had the larg[...] incomes who were most ready to make provision f[...] old age, but some who had very small incomes d[...] so, and were not obliged to ask for assistance of a[...] kind. It was quite an exception for even the poor[...] classes to be obliged to go to other people to he[...] them. The number of those who were reduced [...] distress through other than avoidable causes was [...] small, that it was wholly unnecessary to resort [...] legislation to meet the difficulty; it might safely [...] left to voluntary effort.

Mr. Walter Smartt said Charles Lamb was [...] friend of his (the speaker's) father, and was a ve[...] witty writer, but it was doubtful whether he ought [...] be cited as an authority on the condition of the po[...] in the present day. He died about 57 years ago, a[...] the condition of things had much changed since the[...] It was said that Mr. Booth's scheme would co[...] £30,000,000 per annum, but he did not think [...] could come to so much if only the aged poor we[...] provided for, as that sum would give a pension [...] nearly 2,500,000 people. With regard to t[...] Foresters mentioned by Mr. Brabrook, seeing th[...]

ached such a great age, they had probably drawn tle, if any sick pay, and their contributions, say om 30 to 70, must have amounted, with compound terest, to a very considerable sum. He thought more ipervision was required over the workhouses to see at the inmates were properly treated, and then there ould be no demand for old age pensions. He was formed that at one Union in Essex, the food for e officers cost about 12s. each per week, and for e poor, only 2s. 11d. It might be right for the ficers to have better food, but there ought not to be much difference as that. If old age pensions were troduced at all, they should be introduced gradually, ginning with extreme ages, say 90, and gradually ducing the limit if the plan were found to work tisfactorily. It would also be well for large towns to ace their workhouses out in the country, with land tached, on which the inmates might be employed.

Mr. G. Lloyd Baker said he had had a good deal experience with regard to the savings of the poor, e middle-class, and servants in the country, and he ust say that he had never found that a small come debarred anyone from saving who wished do so. Of course, with a larger income, a larger nount could be saved; but those who did save ways told him that they would have done so if their come had been smaller. He was happy to say that his parish (in Gloucestershire) they were so far om the workhouse, that there was some difficulty applying for relief, and the general influences ought to bear to prevent relief being given, evented most persons from applying; they were pported by their relatives or their own savings. e believed there was only one exception in a parish 600. In neighbouring parishes, where relief as encouraged, people flocked to the workhouse, hough liberal out-relief was given. The question expense was not nearly so important as that of the owing demoralisation of the working classes by king away their responsibility. Now that they had large share in the Government, it was of more portance than ever that they should learn to look rward and provide for the future, and oppose any heme of State pensions. They were the real people no could offer opposition effectively, and it was cessary, therefore, to put before them the real cts, and show them how it would weaken their sition, and make the helpless prey on the rifty. The working classes should be shown that herever taxation came from it must press on em eventually. They, of course, required to ve these things explained, but they might be ought to recognise the facts, and they were lling to listen. If their wages came out of the ckets of those who paid the taxes, it must affect em. He had found it had some effect to point to case like Italy, where taxation was enormous, and here it was laid almost exclusively on the richer sses, and where farm labourers on the richest land ly got 1s. 3d. a day in summer and 10d. a day in winter. If our working men were taught these things they would give their voices against State pensions, and decide to live on their own resources, and maintain their self-respect.

Mr. M. Crackanthorpe, Q.C., expressed his admiration for the very lucid paper. The scheme of Mr. Chamberlain appeared to be open to the objection that it offered no sufficient attraction to the working man. Why was the age of 65 fixed when many large classes of such men knew that their period of real efficiency was from 25 to 50, and that at 45 in many cases, and at 50 in nearly all, there would be a rapid declination of wages, so that long before 65, if a man depended merely on his wages, he would be in a state of poverty? As to Mr. Booth's scheme, he had talked it over with Mr. Booth, but he had never been satisfied of the propriety of the Duke of Westminster bargaining with the State for 5s. a week when he reached the age of 65. Of course, he would not take it, and a great many others would not, but if they were all to subscribe to this fund, and say they were not going to take it, it would have to be confined to the deserving poor, who must be selected by the local guardians, and so they came back again to the Poor-law. There was rather too much unanimity about the meeting, however, and he would throw out one suggestion on the other side, in order that Mr. Mackay might deal with it in his reply. Mr. Chamberlain's scheme had one merit which Mr. Booth's and Canon Blackley's had not: it would tend to stimulate thrift. He did not think it did it in the right way, but it did it, and that was what was wanted in the poorest class. It was extremely difficult to get anyone at the age of 20, not only to think of 65, but to think of the future at all, and, therefore, even at the sacrifice of some individualist principles, they ought to do something. In this country there were about 20,000 friendly societies registered—purely democratic societies—of which the country might be proud; but there were also some 1,700 unregistered societies—some in his own county in the north—which were badly managed, with tables of the most fantastic order, which required frequent revision. A great many working men put their money into these societies, and did not get a *quid pro quo* when the day of payment arrived. Could not the pension scheme be managed by means of a subsidy, not to the individual, but to the society *qua* society, so that only through the society could the advance be derived? That would be an elastic system. which would get rid of the absurd rigidity of the 65 limit, and the society would be subsidised for its general purposes, sick pay, burial fund, widows' fund, &c. By doing that, a certain control would be exercised over the societies; and though he knew they were tenacious on that point, perhaps they might be inclined to waive a little of their dignity in return for such substantial benefits. He thought that that would be stimulating thrift in the

proper quarter, by giving a direct incentive to men to join these societies.

Prof. CLEMENT FOSTER, F.R.S., wished to ask Mr. Mackay a question of only minor importance, but of interest to him, as being largely connected with miners. He understood Mr. Mackay to say that friendly societies were a unique Anglo-Saxon institution, but if it was meant that they were of British origin, he thought it must be a mistake. The miner had not only been a pioneer in settling unknown countries, but also in thrift; and as long ago as the 13th century in Saxony, and, he believed, still earlier in parts of Germany, miners had provident societies for ensuring sick pay and relief in old age.

Mr. MACKAY said the meeting appeared to be so unanimous that he had very little to reply to. He did not quote Charles Lamb as an authority on the state of the poor, but merely in apt illustration of the point he was making. It was an essential point of Mr. Booth's scheme that everyone should be included; you must not hurt anyone's feelings by giving him anything which the Duke of Westminster was not equally entitled to. The remarks on the hardships of the Poor-law were not quite relevant; but with regard to paupers being underfed, he could only say that the dietary was carefully regulated by the Local Government Board, and he had not the least doubt that the pauper fared better in the matter of diet inside the workhouse than he did outside; in other matters it might not be so. He knew that Mr. Lloyd Baker had great experience with regard to the savings of poor people in the country, and it was very desirable, as he said that these matters should be brought home to the working-classes. As far as he (Mr. Mackay) knew, no authorised spokesman of the working-classes had declared in favour of these pension schemes. It was entirely an agitation got up by politicians and well-meaning people, who were not of the working-class. Mr. Tillett, who probably represented the humblest class of London labour, spoke strongly against it, and said what they wanted was better wages during their lives. He had also pointed out that the dock labourer, and many of the rough out of door workers, rarely lived to 65. He (Mr. Mackay) always thought it was a case for speaking out, especially by those interested in Poor-law administration; and he was glad the agitation had been aroused, because it made the working people look into the matter closely, and they were beginning to take more reasonable views. He was inclined to think that Mr. Crackanthorpe had answered himself. He did not think the friendly societies would accept the help offered. They always told him they did not want money, but wanted to manage their own affairs. Mr. Radley said the effect of giving a subsidy would be this: in one case it would not be wanted, and where it was, it would be bolstering up an inadequate scale, and thus making those who managed well pay for those who did not. Inadequat and badly-managed clubs existed principally i localities where the Poor-law was badly ad ministered; where they had really to depend o the club. These rotten public-house clubs tended t die out. He was not so well up as he ought to be i the history of the matter, but at the present da there were no institutions abroad like the Englis friendly societies. Those on the Continent we nearly all subsidised, and in France there was a agitation to get larger contributions from the Stat Here it was exactly the opposite. All the bittere and strongest things against these schemes were sa by the friendly societies. Those societies had a lor pedigree, more or less legendary, some going back t the time of Noah, but he could not answer tl question with regard to the miners with any certaint Mr. Brabrook said, and no one understood the sub ject better, that a considerable number of people r ceived assistance in old age from friendly societie but he believed the figures he gave were corre some time ago, and that the addition had con about mainly because of this agitation; and that was a false start. He did not believe any larg number would provide for old age by means deferred annuities. A friend of his in Berkshire, wl was interested in a society there, managed partly l the working people and partly by the gentry, had pe suaded some 80 or 90 to subscribe for these annuitie but he recently told him that he was in doubt wheth it was a wise thing to do; and it seemed pretty cle that they would not have done it but for the pressu put upon them. The increased number in the Ma chester Unity and Foresters was probably due similar causes.

The CHAIRMAN, in proposing a vote of thanks Mr. Mackay, said the discussion had been eminent satisfactory.

The vote of thanks was carried unanimously, a the meeting adjourned.

APPLIED ART SECTION.

Tuesday, February 21, 1893; LEWIS DAY in the chair. The paper read w "Wall-papers and Stencilling," by T. SPENCE.

The paper and discussion will be printed the *Journal.*

Correspondence.

THE CURRENCY PROBLEM.

In the *Journal* of the 17th inst., Mr. Hyde Clar makes the following statements in regard to paper, as printed in the issue of the 3rd inst. :—

"At p. 231 is a Table of coinage of gold and lver in France from 1806 to 1875, which gives 323,000,000, total, of gold coined, and £217,000,000 silver. If the later figures are taken, from 1846 to 375, the ratios are quite different. £55,000,000 erage, or £275,000,000 total, of gold; and 12,000,000 average, or £60,000,000 total, silver."

What I stated was, that the £323,000,000 of gold id £217,000,000 of silver were coined "at the value 15½ to 1 for equal weights." He is criticising the gures as if I had given them for the purpose of iowing the ratio of the quantities of gold and silver spectively. But the ratio to which I refer has othing whatever to do with the relative quantities the two metals, so that when he states "the tios are quite different," that has no reference to y figures or ratios.

Again he says, "Many of these coins were used r export to foreign countries, where a 20-franc or 5-franc piece is an acceptable coin." This has othing to do with my paper. I did not deal ther with the amount of money in circulation in rance, or with the exports and imports of the ecious metals in regard to that country. I dealt lely with the amount of gold and silver coined the French Mint, and all at the ratio of one ounce gold as the equivalent of 15½ ounces of silver.

As to index numbers, many suggestions have been ade. I took the only complete ones available. ie change for weights may be seen for some years the report of the Gold and Silver Commission; t with that allowance, there is still an enormous l in the average prices of commodities in the gold untries.

In regard to silver, it was not depreciated in ondon in regard to its purchasing power over comodities until July last.

J. BARR ROBERTSON.

February 20.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

MARCH 1.—THOMAS R. DALLMEYER, "Teleotography."

MARCH 8.—"Music in Elementary Schools." By . G. MCNAUGHT.

MARCH 15.—"Technical Education: its Progress d Prospects." By Sir PHILIP MAGNUS.

MARCH 22.—"The Optical Correction of Photophic Perspective." By H. VAN DER WEYDE.

Papers for meetings after Easter:—

'Transatlantic Steamships." By PROF. FRANCIS GAR, LL.D.

"The Construction of Locks and Keys." By HARRY W. CHUBB.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

MARCH 9.—JERVOISE ATHELSTANE BAINES, I.C.S. (Bombay), "Caste and Occupation at the last Census of India." The LORD REAY, G.C.S.I., G.C.I.E., will preside.

This paper will be illustrated by lantern slides of various types of the Indian population.

APRIL 6.—Sir EDWARD N. COVENTRY BRADDON, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisation."

APRIL 27.—Sir JULAND DANVERS, K.C.S.I., "Indian Manufactures." Sir ALEXANDER WILSON, formerly President of the Bengal Chamber of Commerce, will preside.

MAY 11.—Sir RAYMOND WEST, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results."

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock:—

FEBRUARY 28.—SIR EDWARD BRADDON, K.C.M.G., "Russia as a Field for Tourists." Sir PHILIP CUNLIFFE-OWEN, K.C.B., K.C.M.G., C.I.E., will preside.

MARCH 21.—CECIL FANE, "Newfoundland." Sir CHARLES TUPPER, Bart., G.C.M.G., will preside.

APRIL 18.—H. A. MCPHERSON, "The Philippine Islands."

MAY 2.—E. DELMAR MORGAN, "Russian Industrial Art."

MAY 18.—W. B. PERCIVAL, Agent-General for New Zealand, "New Zealand."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

APRIL 11.—PROF. PAUL SCHULZE, "History and Development of Pattern Designing in Textiles." THOMAS WARDLE will preside.

MAY 9.—PROF. W. M. FLINDERS PETRIE, "Primitive Art in Egypt." EDWARD J. POYNTER, R.A., will preside.

MAY 30.—JAMES DALLAS, "Devonshire Pottery."

*** The meeting originally announced for March 14 will not be held, but will be replaced by an additional meeting in May.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Three Lectures.

LECTURE I.—MARCH 6.—Analogy of Alloys to Solutions—Importance of studying the behaviour of Alloys while they liquify and as they "freeze"—Experimental Methods adopted in conducting the investigations.

LECTURE II.—MARCH 13.—Advances in our knowledge of Alloys, since the last course of Cantor Lectures "On Alloys" was delivered in 1888.

LECTURE III.—MARCH 20.—Applications of Alloys in Metal Work, with special reference to the Art Collections in the South Kensington Museum.

LEWIS FOREMAN DAY, "Some Masters of Ornament." Four Lectures.

April 10, 17, 24; May 1.

C. HARRISON TOWNSEND, F.R.I.B.A., "The History and Practice of Mosaics." Two Lectures.

May 8, 15.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 27...Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Dr. R. Milne Murray, "A Wheatstone Bridge specially arranged for Physiological and Clinical Research." 2. Dr. R. Milne Murray, "A Reflecting Galvanometer with Interchangeable Coils." 3. Paper by the late Laurence Hill, "The Non-Automatic or Confidence Water Meter."

Geographical, University of London, Burlington-gardens, W., 8½ p.m.

British Architects, 9, Conduit-street, W., 8 p.m. Messrs. E. Ingress Bell, Leonard Stokes, and S. H. Leech, "Terra Cotta."

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. Klein, "Bacteria: their Nature and Function."

TUESDAY, FEB. 28...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Sir Edward Braddon, "Russia as a Field for Tourists."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Functions of the Cerebellum, and the Elementary Principles of Psycho-Physiology."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-st., S.W., 8 p.m. 1. Discussion on Dr. Edward Hopkinson's paper, "Electrical Railways." 2. Mr. Walter Pitt, "Plant for Harbour and Sea Works."

Sanitary Institute, Parkes' Museum, Margaret-street, W., 8 p.m. Mr. C. Mason, "Scavenging and Disposal of House Refuse."

Photographic, 5A, Pall-mall East, S.W., 8 p.m. Discussion on "Panoramic Photography."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Dr. C. J. Forsyth-Major, "Some Miocene Squirrels, with remarks on the Dentition and Classification of the *Sciurinæ* in general." 2. Mr. Henry O. Forbes, "Observations on the Development of the Cetacean Genus *Mesoplodon*, with Remarks on some of the Species. 3. Mr. F. E. Beddard, "The Brain of the African Elephant."

Society of Architects, St. James's Hall, Piccadil[ly,] W. 8 p.m. Mr. Edgar Farman, "The Princip[les] and Practice of Voluntary Arbitration."

WEDNESDAY, MARCH 1...SOCIETY OF ARTS, John-stre[et,] Adelphi, W.C., 8 p.m. Mr. Thomas R. Dallmey[er,] "Tele-photography."

Medical and Chirurgical, 20, Hanover-square, W., 5 p.m. General Meeting.

Archæological Association, 32, Sackville-street, W., 8 p.m.

Obstetrical, 20, Hanover-square, W., 8 p.m.

Archæological Institution, Oxford-mansion, Oxfo[rd-]street, W., 4 p.m.

THURSDAY, MARCH 2...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. [Mr.] H. N. Ridley, "The Flora of the Eastern Coas[t o]f the Malay Peninsula." 2. Mr. J. M. Macc[oun], "The Behring Sea Islands and their Flora."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. [H.] E. Armstrong, "Notes on Optical Properties [a]s indicative of Structure (postponed)." 2. Mes[srs]. P. Frankland and J. MacGregor, "The Ethe[real] Salts of Active and Inactive Glyceric Acid." [3.] Mr. T. R. Rose, "Limits of Accuracy of Gol[d] Bullion Assay, and the Losses of Gold incide[nta]l to it; the Volatilisation of Gold." 4. Messrs. F. Cross, E. J. Bevan, and C. Beadle, "[The] Interaction of Alkali — Cellulose and Car[bo]n Disulphide." 5. "A new Atomic Diagram [an]d Periodic Table of the Elements."

London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. H. Cummings, "The Rightful Positio[n o]f England as a Musical Nation."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. P. Geddes, "The Factors of Organic Ev[olu]tion."

Camera Club, Charing-cross-road, W.C., 8 p.m. Mr. W. Jerome Harrison, "Composite Ph[oto]graphy with Films."

East India Association, Westminster Town H[all], S.W., 4½ p.m. Hon. Mr. Justice Jardine, "T[ria]l by Jury in England and India."

FRIDAY, MARCH 3...United Service Institute, White[hal]l Yard, 3 p.m.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. George Simmo[nd]s, "Sculpture: considered apart from Archæolog[y]."

Sanitary Institute, Parkes' Museum, Margaret-str[eet], W., 8 p.m. Prof. A. Wynter Blyth, "Disease[s o]f Animals in Relation to Meat Supply, Character[isti]c of Vegetables, Fish, &c., unfit for Food."

Geologists' Association, University College, W[.C.], 8 p.m.

Junior Engineering Society, Westminster Pa[lac]e Hotel, Victoria-street, S.W., 8 p.m. 1. Mr. J. Tennant, "Expansion Curves." 2. Mr. W. DeRitter, "Feed-water Heaters."

Philological, University College, W.C., 8 p.m.

Quekett Microscopical Club, 20, Hanover-squ[are], W.C., 8 p.m.

SATURDAY, MARCH 4...Royal Institution, Albemarle-str[eet], W., 3 p.m. Lord Rayleigh, "Sound Vibratio[ns]."

The Telegraphic Address of the Society of A[rts], and of the Royal Commission for the Chic[ago] Exhibition, is "Praxiteles, London."

ournal of the Society of Arts.

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FRIDAY, MARCH 3, 1893.

'communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

[he attention of members is specially called the alteration of the hour of the course lectures to be delivered by Professor ANDLER ROBERTS-AUSTEN, C.B., F.R.S., March 6th, 13th, and 20th. The lectures will nmence at 5 p.m. instead of 8 p.m. The)ject is "Alloys."

)CIETY OF ARTS EXCURSION TO CHICAGO.

:he Council of the Society of Arts, acting the Royal Commission for the Chicago iibition, have arranged with Messrs. Thos.)k and Son to organise a special private ursion to the Chicago Exhibition for mbers of the Society of Arts. The excur- 1 will last from July 22nd to August 23rd, l will cost £65.

)etailed particulars of this tour have been t to the members, but further particulars y be obtained on application to the Secretary.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

. meeting of the Royal Commission was 1 on Monday, 27th February. Present: Sir hard Webster, Q.C., M.P., in the chair; Frederick Abel, K.C.B., D.C.L., D.Sc., :.S., William Anderson, D.C.L. F.R.S., George Birdwood, K.C.I.E., C.S.I., D., M.D., Sir Edward Birkbeck, Bart., Sir vard Braddon, K.C.M.G., Sir Frederick mwell, Bart., D.C.L., F.R.S., Major- ieral Sir Owen Tudor Burne, K.C.S.I., C.I.E., hael Carteighe, B. Francis Cobb, Professor ies Dewar, M.A., LL.D., F.R.S., Sir Henry lton, James Dredge, Professor Clement Le e Foster, D.Sc., F.R.S., Sir Douglas :on, K.C.B., D.C.L., F.R.S., Walter H. ris, John Biddulph Martin, John O'Connor, B.L., Professor William Chandler Roberts-Austen, C.B., F.R.S., and Sir Owen Roberts, M.A., D.C.L., F.S.A.

THE LATE COLONEL GROVER.

The following letter, containing a resolution passed at a meeting of Foreign Commissioners and officers of the Chicago Exhibition, has been received :—

World's Columbian Exposition,
January 31, 1893.

Sir Henry Trueman Wood, Secretary Royal Commission of Great Britain for the World's Columbian Exposition.

My Dear Sir,—I have the honour to inform you that a meeting was held in the Department of Foreign Affairs, Jackson-park, at noon to-day, all the Commissioners of foreign countries and the officials of the Exposition being present. The Director-General presided, and the Secretary of the Department recorded.

Addresses of affection and regret were made by the Director-General, the Honourable Walker Fearn, Chief of Foreign Affairs, and the Honourable Adolf Wermuth, Imperial German Commissioner, and, as expressing the sense of the meeting, the following was adopted :—

> "It having pleased Almighty God to remove from our midst our late associate, Colonel George Edward Grover, of the Royal Engineers, the Official Representative of the British Commission to the World's Columbian Exposition, we desire to record our appreciation of the worth and high character of this distinguished gentleman; of his brilliant abilities as an executive officer, and of his singularly lovable personality; and we tender to the Royal Commission the assurance of our deep sense of the common loss, and to his afflicted widow and family our heartfelt sympathy and lasting condolence."

It was decided to attend the funeral in a body, and the meeting adjourned.

I have the honour to be
Your most obedient servant,
(Signed) Richard Lee Fearn, *Secretary, Department of Foreign Affairs.*

At the meeting of the Royal Commission, on February 7th, the Chairman, Sir Richard Webster, Q.C., M.P., referred to the lamented death of Colonel Grover, and bore testimony to the great value of his services as the representative at Chicago of the Commission. It was unanimously resolved that a letter be addressed to Mrs. Grover, expressing deep sympathy with her and her family in their sad bereavement.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, February 21, 1893; LEWIS F. DAY in the chair.

The paper read was—

WALL-PAPERS AND STENCILLING.

By T. R. SPENCE.

The first record of the manufacture of paper-hangings in England dates from the year 1692, as a patent was taken out at that date by a William Bayley, who stated that his invention consisted of "several engines made of brass," for the printing of all sorts of paper, of all sorts of figures and colours whatsoever, and that "the said invention had not been heretofore known or practised by any of our subjects." There is no doubt the first attempts were the imitation of tapestry, linen, or other hangings that were at that time fashionable. In the reign of Queen Anne, 1712, a duty was imposed on paper-hangings. They were made on pieces, 16 to 24 sheets, forming about eight square yards; each sheet bore the Government stamp; the duty was 1¾d. per square yard. Paper stainers were required to pay an annual licence of £4.

In the reign of Queen Anne, paper-hangings were imported from China. Probably the first idea of their manufacture here was suggested by these importations. In 1746, larger blocks were used for wall-paper printings, some two yards long, made from light material, but these were soon found unsuitable, and were replaced by heavier and shorter blocks.

In 1753, Edward Deighton used engraved metal plates in a rolling mill. The designs were afterwards coloured by hand, gilding of parts was also introduced by him—doubtless suggested by the gilded leathers used in the 16th centnry—for wall covering. A man named Jackson, about this time, made and sold papers in imitation of statues, landscapes, &c., and quaintly remarks that "the persons who cannot purchase the statues themselves may have these prints in their places and thus effectually shews his taste." Whether his cheap antiques "caught on" I am unable to say. In a work printed by J. Nourse, in 1764, it is stated that there were three methods in use, namely, printing in colours, using the stencil, and painting with a pencil or brush.

These processes are described at some length, and approached the block printing now in use. Stencilling was found to be cheaper, but not so sharp as blocks. The pencil was used for finishing and adding further details. Flock printing was also described as giving faithful imitations of silks, velvets, damask, &c. A piece of paper was taken off the walls of a mansion near Whitehaven in 1786; it was asserted that it had been there for about 200 years. Its thickness was that of cardboard, and had evidently been fixed to the wall with varnish. The ornament had been stencilled and afterwards finished by hand.

Sherringham, of London, in 1786, as the result of journeys to the Continent, made great advances in the art of paper staining.

Antony G. Eckhardt, in 1792, made papers from engraved copper plates, and decorated them with silver and gold leaf. This gilding was the invention of John Hautch, of Nuremburg, about the middle of the 17th century. It was a preparation of tin and copper, and is now commonly known by the name of Dutch metal. Eckhardt also printed on stiffened linen, finishing by gilding and varnishing, and employing artists of considerable skill.

In 1796, T. G. Hawcock was the first to introduce embossed paper.

In the picture galleries at Hampton-court Palace are the remains of wall-papers, which are asserted to date from the time of Charles I. There are, or were, some old flock papers on the walls of King William's bed-room, dressing-room, and writing-room. The date of their production I cannot state. They may not be very old, as the patterns are like the patterns used 50 years ago. Paper hangings 50 years ago were made of several sheets, 23 × 28, fixed together in lengths of 12 yards. Lewis Robert, a French workman, in 1799, made a machine for producing paper in endless pieces; and, in 1803, John Gamble obtained a patent in England for making paper in endless sheets.

In 1836, the reduction of the duty gave a great impetus to wall-paper manufacture, with the result that their use was very much increased. In 1861 the duty was altogether abolished.

The first process in wall-paper manufacture is the preparation of the design. This, as a rule, is sketched out roughly sometimes to a small scale, but more frequently plotted out to the actual size necessary for the rollers or blocks in which it is to be cut. The usual area for roller printing is 21 in. by 21 in.; block printing gives a more extended surface,

rying from 21 in. by 24 in. to 24 in. by 36 in. [I]n these areas the artist has to express him-[sel]f as best he may, for the design must [ne]cessarily repeat itself correctly in these [sp]aces. Should the designer be dowered [wi]th redundant imagery, these inexorable limitations become a tyranny and a chilling frost on his dreams.

It is well to work on a piece of paper 6 in. larger all round than your 21 in. by 21 in. In the middle of this allotted space, the design may be roughly sketched, running out certain

Fig. 1.

The White Peacock Frieze,
Designed by Walter Crane.

l[ar]e general sweeping lines across and into t[he] outer spaces. The general purpose and d[ire]ction of such lines the designer will have i[n h]is mind's eye, and if he is a fairly skilful d[ra]ughtsman, he may come very near the c[orr]ect points on the edge of the space necessary for the repetition of his pattern. Unless the designer's conception first lives in his mental vision, it will not come by any fishing process, or without previous thought or creation.

This rough design is roughly traced and

placed at the sides, top, and bottom, so that the curves or other detail shall work out the correct repetition of the pattern. There are certain rules for working out in geometric patterns, but they are too complicated for present description. Some prefer to get the pattern in somewhat of a muddle, as the process of unravelling stimulates mental effort and invention—to fill up undeveloped spaces—thus obtaining more interest and thought in the detail.

When the whole design is complete in outline, it is transferred to a sheet of paper of th tint that is to predominate in your colou scheme; on this are laid the various colou in distemper as shall be used for subseque printing. The design is carefully traced an transferred to rollers or blocks, which a destined to print the pattern on the paper.

These rollers have to be prepared with gre care, and to be of thoroughly seasoned syc more. All outlines of flowers, grounds, &c are formed by driving into the wood, up to gauge, copper slips, and the intervenin spaces filled with felt, thus forming the printing surfaces. Sometimes the rollers are covered with paper $\frac{1}{8}$ inch thick, and the copper slips are hammered through into the wood, the paper acting as gauge. The paper is picked out and the spaces fitted with felt. The copper bordering keeps the whole design sharp and permanent. The edges formed by the incised printing pattern, if of wood only, soon becomes ragged and worn.

FIG. 2.

THE TROCADERO.
De.igned by Lewis F. Day.

Each colour requires a separate roller, and when attempts are made to imitate the colours and gradations of natural flowers, it is uncommon thing to have 20 separate rollers

The enormous cost of cutting 20 rollers the printing of one paper, should be the mea of opening our eyes to the fact that, if wa papers are to conform to the best traditi of decorative art, such a multiplicity of ti can never be satisfactory. All fine decorat is simple, and of a limited scale of tints a gradations. Manufacturers now, in employ designers, generally stipulate a limited num of printings, on the score of expense of prod

FIG. 3.

THE WINDSOR CASTLE.
Designed by L. Aumonier.

on. They thus, shall I say unconsciously, are furthering the best decorative ends, remembering that wall-paper is an adjunct, within the reach of moderate means only, not the whole end and ideal of decorative art.

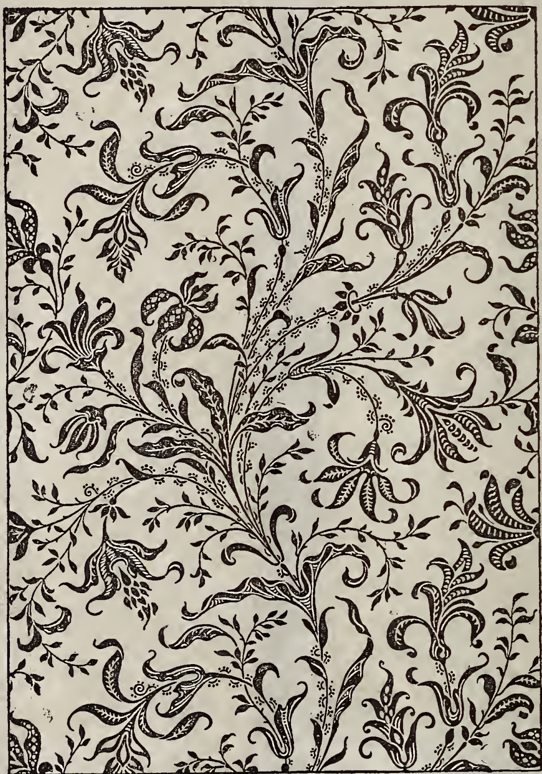
For roller printing, the rollers are very accurately mounted on a large revolving cylinder, the latest type of cylinder being capable of carrying 16 printing rollers, thus, at each revolution, turning out a paper containing 16 printings. The paper is first carried from a smaller supply-machine, which regulates the supply and tension of the material against the rollers, these being supplied with the necessary print-

ing tints from an endless blanket roller, revolving through troughs of colour. When the paper has received its printed pattern, it still further travels over a succession of rollers, through the drying room ; when perfectly dry, it is transferred to a machine, for cutting into lengths of 12 yards. A machine carrying two rollers produces paper at the rate of about four miles an hour.

In the blocks which are to be used for the hand-printing of wall-papers, the design is first traced upon the block, and the portions which are not to be printed are cut away, leaving the design, as originally traced, i relief, and this relief surface, of course, take the colour from the colour blanket, and tha with lever pressure, transfers itself to th paper. Occasionally, however, where th lines in the drawing are very fine, it necessary to use metal slips, as the woo would be liable, in washing and in the proce of printing to break away, or at least to war The block is previously dipped in a blanke lined trough containing the colour.

In hand block-printing, the paper is dra across a long table. The printer places h

Fig. 4.



The Calstock.
Designed by T. W. Hay.

block accurately on the paper, the former being regulated by him at each corner with gauge pins, to ensure accuracy at each length of printing. Then pressure, through an upright lever, is applied, and the impression made.

Blending is obtained by coating the blanket with a number of tints. An oblong trough, containing a number of varying colours, stands near the printer and the attendant, with a long brush, dips it into the trough, and then brushes it over the blanket. Sometimes the blanket is merely dabbed over with several patches f colour. The colour is then transferred to t block, as previously described, the res giving blended and varying tints to differe details of the design.

When the paper comes from the ma facturers it is of one uniform white tint, a requires the application of colour groun The paper is carried through a machine on endless roller, over a large cylinder, above whi are fixed a succession of brushes, which a

different degrees of coarseness or fineness, may be desired to give varying textures. ıe paper comes in contact with an endless lour soaked blanket which supplies the colour. 'ter passing the brushes it travels over smaller llers into the drying room, the length of its ırney being regulated to complete its drying.

No. 5.

No Man's Garden Design.
Designed by C. F. A. Voysey.

'lock paper hangings are printed in the ails of the design in size. The flock—ich is composed of the cuttings of woollen th, cut up in a mill to the necessary degree fineness, and dyed—is then sprinkled over paper adhering to the part charged with :. To get a higher surface the sizing and inkling is repeated.

Gold is applied much in the same manner, metal dust being sprinkled on to the paper, l adhering to the forms previously printed size. Gold leaf is sometimes used, and ːrwards drawn through a machine for burıing.

Ordinary embossed papers are drawn through a machine into which is fixed a cylinder of brass, on which is cut the necessary raised design. Other methods are used, the paper being prepared with gum size, parts are gilded, and then the paper is stamped with heated metal dies.

Fig. 6.

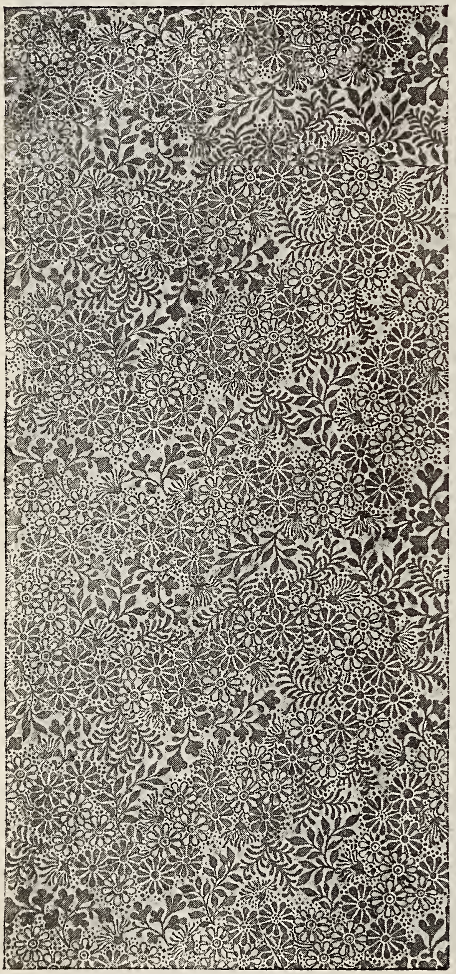
The Tokyo Design.
Wall-paper. Designed by C. F. A. Voysey.

Embossed flock is the result of embossing on the top of ordinary flat flock.

The glittering grounds so much in vogue are produced by dusting on talc before the ground is perfectly dry, the gum contained in the colour forming a size to which the talc adheres. These grounds, if used sparingly, give brilliant results. Fine effects are produced by printing in transparent colours on these grounds.

The most sumptuous wall papers are those in imitation of embossed leather. The best of these have all the artistic qualities of the latter material, the only difference being that the leather will wear longer, but in the paper there is nothing to complain of on this score. The production of these is an expensive process. If cost debars us from using the material in large quantities,

FIG. ⁓.



THE MAY-WREATH DESIGN.
Wall-paper. Designed by G. Haité.

it can be used for friezes, say above a high oak dado, or in squares or panels. The first process in manufacturing these is to have the design embossed on a copper sheet by a man possessed of the best artistic feeling obtainable; every valuable line and form of modelling by the artist will be afterwards faithfully reproduced in the paper. From these embossed copper sheets an electrotype is taken, which forms the matrix into which the paper is pressed when in a moist state. Such a method results in far superior quality to impressions from roller plates. The surface is gilded with

FIG. 8.

THE WILDWEED DESIGN.
Wall-paper. Designed by G. Haité.

gold leaf or Dutch metal, and afterwar[ds] entirely painted by hand. These Englis[h] made papers are much more permanent th[an] Japanese leather paper, and, I am sure, equ[al]

em in artistic qualities. Another treatment these is to print with lacquers on a gold ound, obtaining the beauty of transparent nes of colour.

There are many other forms of wall-covering ade of paper, such as Japanese leather papers. ncrusta anagleptic Tynecastle tapestry, &c., iich I refrain from describing, as they would quire an evening devoted to them entirely.

FIG. 9.

THE IGHTHAM DESIGN.
Wall-paper. Designed by T. R. Spence.

In addition to printed paper decorations, iere is another and older method called tencilling, capable of many varied and deghtful results. By cutting out in paper, zinc, or brass plates, ornamental forms, and laying them on a flat surface, rubbing through with short stumpy brushes charged with colour—thus transferring the design to the object on which it is laid—any number of tints may be used, each requiring a separate stencil-plate through which are cut the forms of each detail of each colour. There are two general methods of stencilling, the first, which gives the actual design in the colour applied; and the other, where the stencil is cut to form a background, so that the forms of the design are expressed by the original colour of the ground. The latter, in cases where practicable, gives the purest and most brilliant result. I am not able to say whether the ancient Egyptians and Greeks used this method for the numerous repetitions of their conventional designs of the lotus and acanthus. Were we using such ornament now, this method would form the first stage, if they were afterwards worked on by hand. However, the historical aspect of the subject is not in the present instance of importance. There is little doubt stencilling was largely used in the Middle Ages. In various parts of Italy and France I have seen the roofs of churches and the ceilings of palaces covered with charming examples of pure stencilling. It was very much in vogue during the last century and the beginning of this. In Indian temples it has been largely used. During the last century there were several guilds of stencillers, as it was an important form of industry. The Japanese have used it for the decoration of various materials, many of their silks and other dress materials being covered with ornament executed in this manner. Their skill in cutting the most delicate lines and forms has enabled them to execute the most wonderful and complicated schemes of colour decoration on almost any substance. They cut the patterns in paper made of mulberry fibre, four or five at a time, with a long thin knife and delicate punches. When finished, one sheet is covered with some adhesive material. On this is placed a number of threads of silk, which form ties to hold the whole design together. This process completed, another cut sheet is placed over the threads and underlying stencils, and the whole pressed accurately together. I believe in many human hair is used instead of silk.

All the same effects as are found in wall-papers may be achieved by stencilling. From the examples shewn here of stencilling applied to wall-papers by an advanced modern method, we find qualities much beyond what is usually

accepted as stencilling. The process is not to be described any more than that of painting a fine water-colour, in which the artist uses numberless methods of his own to arrive at the expression of his idea. You may stencil bright ornament on a dead ground, or *vice-versa*. The forms may be raised with repeated application of colour, or stencilling may be executed on any specially prepared uneven textured ground. It may and is used largely for stencilling in the general colour of any ornament on which you propose to relieve by shading or tinting, and is a very simple and direct method for accurate setting out, as it were, elaborate arrangements of ornament for such subsequent finish. In the decoration in ornamental forms of large interiors it forms the basis of all detail.

In cutting stencil plates, ties are necessary, in every detail, to hold the plates together. These, if judiciously distributed, form a great additional element to the beauty of the design, giving a fillip of light over the decorated surface. A practice to be condemned is what is termed the mending of ties. This method takes all the life out of the work.

In conjunction with wall-papers, stencilling has many uses, such as the filling of forms where the set pattern of the paper will not apply, and is very effective in filling in special forms, such as the spandrils of arches, recesses, friezes, oddly enclosed and moulded spaces. Given such unusual shapes, opportunities occur for giving your whole scheme of decoration a fillip, additional interest, and unity.

In the wall-papers now produced by many manufacturers we have, at a moderate cost, a means of using a very extended scale of the finest ornamental forms clothed in garments of an almost infinite number of colour gradations, whether the schemes in detail are strong, broad, or delicate. Those who possess any innate sense of good colour, and a perception of the conditions of lighting and forms of rooms, may, in their homes, have their love of harmonies gratified.

Now that our education in decoration (as exemplified in wall-papers) has been so much advanced during this last 20 years, instead of using narrow strips or borders about three inches wide, we crown our wall spaces with a frieze from 12 in. to 24 in. wide, thus having a fairly liberal decorative area. Such dimensions, I think, might be increased with advantage to 36 in. or even 40 in. The frieze is now generally divided from the wall filling below by a moulded picture rail 2½ in. deep, making a pleasant and decided separatio between the two.

These mouldings have a groove on the uppe edge, into which small brass hooks are place on which to hang pictures. It is both a usef and ornamental treatment, and obviates th use of brass rods, which are difficult to fix an soon tarnish.

I advocate the use of a deep 30″ frieze fo various reasons. In the first place its generou area cuts to some degree the fetters of th designer. Here he may do his best, and whe it is fixed we get the true and undisturbe value of his imagination. All the pictures bein below his scheme of decoration, the mouldin and frieze defeats that common practice c hanging pictures near the ceiling, and c building them up in pyramids on the wa under the vain delusion that they "match."

We quite forget that the treasures we han on our walls are there for the delight of examin ation, and consequent revelation of whateve charm they may possess in themselves. B means of the picture rail and deep frieze w get nearly all our pictures on the line. This i the haven in which the artists who produc them would have them rest. The best positio for all landscapes should be where their hori zons are level with the eye. So also figure should have their eyes level with the spectato if possible.

I have no sympathy with the common ide that you decrease the apparent height of you rooms by deep friezes, supposing you do suffe from the optical delusion of losing 6 in. I there not a sense of quaintness and comfort i a room that is low? At any rate, we all fee how pleasant and cosy are the old farmhouse with low timbered ceilings. This sense c snugness is well illustrated at the Chateau c Blois, where the timbered ceilings of the room are comparatively low, and are coloured a se green blue, to which is superadded an abur dance of coloured and stencilled ornamen There is a sense of restfulness and comfort i the two small ante-rooms (having ceilings of similar character of decoration) which com between the two great halls or Counc chambers in the Ducal palace in Venice. Th vast pictures by Veronese and Tintoretti i the large halls are wonderful in themselve but I venture to say they do not express th same quiet decorative fitness as do these sma ante-rooms. The same may be said of th suite of small low ceilinged rooms which we the favourite private apartments of Isabell d'Este, in the Ducal palace at Mantua.

This palace is by many considered the most agnificent example of interior decoration of e renaissance. Yet these rooms and their corations only live in one's memory out of e hundreds of magnificent apartments in this st palace. I can well imagine the haven of st they must have been to the daughter of the errara's, amidst the turbulent magnificence the Gonzago's. Of course, they have the lded charm of low windows and vistas of the ombard plains. In the Palazzo Rezzonico, w occupied by Mr. Browning, is a magnificent ite of reception rooms decorated by Tiepolo; tached to these is a suite of smaller rooms, lightfully quaint and low, showing that the d Venetians had combined with a love of agnificence a true appreciation of the pleasure be found in a low and shadowed retreat. I by no means deprecate the fine sense of space and magnificence of rooms having large and generous dimensions, but, we who of necessity must live in apartments of small dimensions, should accept their proportions and devise our treatment accordingly, not cherishing the fallacy that good decoration consists of delusions of scale.

All papers used in staircases, and other apartments where the light is defective, should have their ornament bold and strong, delicate combinations of tones being reserved for rooms well lighted. There is a tradition that all ceilings should be light in scale. Well, many should be, but they may be successful in deeper and richer tones.

Remember the blue of a summer sky sometimes, and use it as a suggestion.

Fig. 10.

The Scroll Frieze.
Designed by T. R. Spence.

Gold on ordinary papers, when perfectly flat, s not always pleasant. The true glory of gold efuses to express itself except on undulating urfaces, where its metallic lustre is developed. In colouring the surrounding woodwork of ooms, it is a comparatively safe rule to select tint from some section of the ornament in the vall-paper. In selecting wall, frieze, and eiling papers, it is well that the wall-paper hould be darkest in tone, the others ascending n the scale of light, and each having the same ints of colour running through, but in varying legrees. This is recommended as avoiding n effect of disturbed harmony; but possessing colour instinct, daring arrangements of contrasts may be accomplished with success. I should say, avoid marbled wall-papers, even if a Tadema is outside your means.

The great weakness of English colouring is its paucity. There is no reason why our wall papers should not be fuller and richer, containing more primaries and less dirty tones. The shadows made by projecting furniture and the absence of really brilliant light, will always soften and give negative tones.

The old Venetians revelled in the fulness of tones; why should we not follow their example, and take suggestions from their source of inspiration, which was the barbaric splendour of Eastern colour? We all recognise and admire the redundant richness of colour as found in Persian fabrics, Japanese lacquers, and Mo-

resque tiles. If this wealth and brilliancy is a delight in sunnier lands, it should be doubly welcome to us, where grey days are our portion, and the consequent need of the joys of colour charm all the greater.

It is an error to think that on a ground of strong colour our pictures suffer. If we take

FIG. 11.

THE SYON DESIGN.
Wall-paper. Designed by T. R. Spence.

care that our areas of colour are flat, and contain some sense of broad unity in the whole scheme, this will not occur. I mean in the absence of every disturbing or restless detail, such as we find in the elaborately printed efforts to reproduce naturalistic flowers, &c. I feel that these backgrounds may be as strong as you like, if the parts are well balanced, and each colour of pretty near the same depth of tone. Gold or black picture frames are a sufficient separation. Besides, these being nearest the eye, are made up of mouldings, such modelled forms carrying the highest lights and the strongest darks, lift them clearly away from the merely surface colour on which they hang. If you place any actual object on the most powerfully painted picture it will always tell as a strong disturbing element.

As the best French painters teach, the accessory, or object to be represented on the first plane, or nearest to the spectator, should carry the highest lights and the intensest darks. Strong lights may be used in the receding plains of the picture; but, to express their relative relations, the gradations of the shadows must be weaker in degree as distances are expressed.

This constructive method is, therefore, a question of values, so that the assertive expression of a moulded form cannot be much weakened by a backing of flat colour. Black or gold, even if assertive, is always valuable in any colour scheme. No one knows this better than the Easterns, as you will find these two elements playing an important in all their compositions.

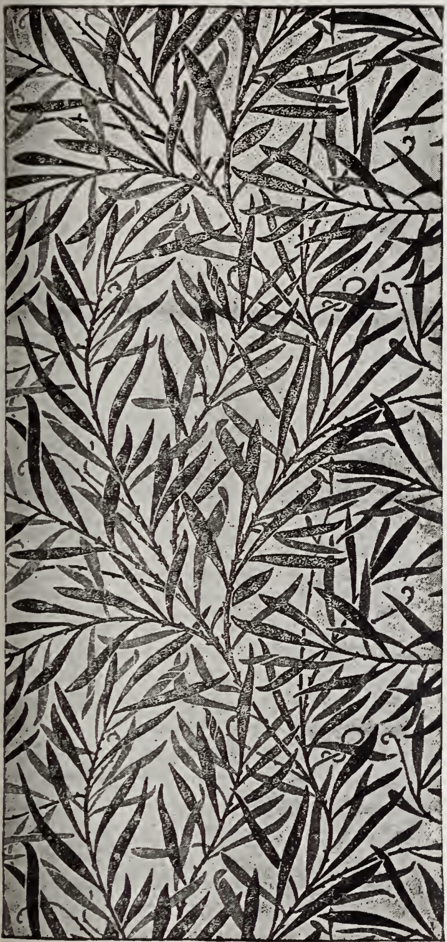
When gold is used, it should be in liberal areas, not in thin strips, which is commonly known as "hatching." A common cry now is, that what is termed an "all over" treatment is best; that is, the areas of the details of the design should be nearly all equal, so that no feature should obtrude itself in the design. I am not altogether in sympathy with this variation in areas; the treatment may be rendered quiet in effect by a nearer relationship of tones in the colouring. If certain strong elements in the design assert themselves, in horizontal and perpendicular lines, why quarrel with such results, as nearly all fine expression in architecture is obtained by the accentuation of horizontal or vertical lines; triangular assertions of features are certainly objectionable.

I have every reverence for the great designs of the past and its suggestions, and there are certain dignified uniting lines and forms that we may well borrow from the *Renaissance*, or other periods of ornament, which are invaluable in the expression of vertical or horizontal forms necessary to fill certain decorative spaces, but underlying or woven into such valuable accentuating forms of expression there should be

lded something of the designer's own individuality or creation. I am sorry to see so uch borrowed from the period of the decline f fine styles.

It is lamentable to see the present craze for e slavish copying of French Rococo ornaent, a period containing all the worst features f an expiring art. How these can be accepted preference to the fine English feeling for

FIG. 12.



THE TWICKENHAM DESIGN.
Wall-paper. Designed by T. R. Spence.

design and colour, exemplified in the productions of our manufacturers during the last 15 or 20 years, is a mystery to me. The French papers at the Exhibition of 1889 may have created this fashion. If such is the case, the influence has been on the wrong side, for I am sure the wealth of colour, original, and artistic design of the English exhibits of this material completely threw in the shade the worn-out features of French design. Their patterns gave evidence of archæology dressed in smart new clothes only, not of any new thought.

Two of the most important qualities in decorative design for wall papers should, I take it, be a general flatness and colour harmony.

By the former I mean the spaces of colour

FIG. 13.

THE TINNEVELLY DESIGN.
Wall-paper. Designed by T. R. Spence.

forming the scheme should be flat in themselves. If any attempt is made at relief, it should be of a rigid or conventional character, in the form of precise lines, or melting gradations, following and accentuating the leaves and other forms, &c. Flowers modelled with endless printings defeat the repose and breadth of wall-paper as a decorative accessory. How can we hope to give the adequate

subtlety of the numberless gradations of flowers by machine printing and the crudeness of distemper colour when the best of the Dutch flower painters fail, with all their delicate manipulation, endless labour, and the wider range of possibilities of the mediums of oil or pure water colour, in rendering perfectly the numberless subtle tones of flowers?

The aim of wall-paper decorations is not realism.

If flowers and foliage are the source from which our creation springs, we should try to give an idealization of their charms, coupled with a subtle and critical selection of those parts that assume the finest curves, and give the most interesting areas of colour. This idealization must be expressed by what I may term convention, or a fine sense of adaptation and ordered arrangement to its decorative purpose.

We venture on a thorny path when we talk of the artistic treatment of wall papers. Any theories that I may have propounded are only those of an individual. Gather lessons in decorative colour from the broad unity and tender harmonies of twilight, rather than the restless brilliancy of noon.

We are now so stored with knowledge of every period and style of decoration that the expression of any personal views or attempts at creation is like venturing on thin ice.

We hear from one that the archaic work of the Greeks is greater than its perfect fulfilment in the age of Phidias; from another that the art of the Mediæval ages embraced all that was living and fervid. Raffaelle and Michael Angelo are torn from their thrones to make room for Carpaccio, Bellini, and Bottocelli. Rembrandt gives way to Velasquez. Preraphaelism is asserted to be a dead letter, and the new and brilliant planet, dubbed impressionism, to contain the cream and embodiment of all art, and so on and so on.

I make no apologies for quoting the great painters of the past as bearing on ornament. I maintain that mere ornamentalists have not given us better decorative forms (exclusive of figures) than the former.

The searching nature of a painter's practice goes deeper into the mysteries of colour in relation to nature, and when he adds ornament to his work, it is, I take it, more subtle than that of the man whose aim is on a lower scale.

I fail to find ornament containing more colour, harmonies, and invention, than that found in the works of Francesca, Carlo Cravelli, Mantegna and Holbein.

It seems to me, the invention, beauty an[d] variety of ornament as displayed in Mar[n]tegna's frescoes in the church of the Erima[n]tana at Padua, the castle of Mantua, and th[e] church of S. Zeno in Verona has never bee[n] excelled by men whose sole function is th[e] making of ornamental design. The strengt[h]

Fig. 14.

Wall-paper. Date 1840.

vigour, redundance of colour, and decorativ[e] fitness, displayed by him in the use of apple[s,] lemons, pomegranates, olive and laurel leave[s,] &c. (which are so essentially decorative i[n] themselves, quite independent of archæologic[al] detail), show a veritable triumph from [the] decorator's point of view.

We may endeavour to unweave the web of ıshions and infatuations for distinct periods, nd clearly find that in all of them great ·uths and precious jewels of beauty were erpetuated. There is one advantage in these ıshions, namely, that the close research into ach period of each man's work reveals a special harm of its own. They tell the ordered story f the revelations that were vouchsafed to ıemselves. The horizons of their accomplishıents should not, however, enfold ours; from ıem we may gather guidance and suggestions nly, which shall increase the clearness of our ıental visions in endeavours to evolve newer ›rms of beauty from the treasure-house of ature. Let not our accumulation of knowedge forge fetters, to dull or stifle the creative ualities with which we may be dowered. Remember that design is not adaptation only. When we have re-adapted, placed here, laced there, turned round and twisted in umberless ways the details of other periods, ntil the hackneyed forms become a weariness ather than a pleasure amongst our household ods, we may awake to the conviction that here is, in the garments of the earth, an inexaustible mine of lovely colour and forms cryg out for translation.

Why not, metaphorically, sail with the bees own the summer winds, and sip the honey of uggestions (so fraught with the seeds of creaion) from a thousand flowers, from the sinuous natomy of trees and plants, the plumage of irds, the colour harmonies of shells and utumn leaves, of moss and lichen, and the ountless details of nature? If your worship of er is sincere, then will follow the clearness of ision to grasp her revelations.

I must tender my sincere thanks to Messrs. effrey and Co., Messrs. Woollams and Co., Messrs. Essex and Co., and Messrs. Hayward nd Sons, for their kindness in exhibiting so nany beautiful examples which clearly show he premier position our English manufacturers old in the production of this material.

LIST OF ILLUSTRATIONS.

Fig. 1. "The White Peacock Frieze." Designed y W. Crane. Printed by Messrs. Jeffrey & Co.

Fig. 2. "The Trocadero." Designed by L. F. Day. Printed by Messrs. Jeffrey and Co.

Fig. 3. "The Windsor Castle." Designed by . Aumonier. Printed by Woollams and Co.

No. 4. "The Calstock." Designed by T. W. Cay. Printed by Woollams and Co.

Fig. 5. "No Man's Garden." Designed by C. . A. Voysey. Printed by Messrs. Essex and Co.

Fig. 6. "The Tokyo." Designed by C. F. A Voysey. Printed by Messrs. Essex and Co.

Fig. 7. "The May-wreath." Designed by G. Haité. Printed by Messrs. Essex and Co.

Fig. 8. "The Wildweed." Designed by G. Haité. Printed by Messrs. Essex and Co.

Fig. 9. "The Ightham." Designed by T. R. Spence. Printed by Messrs. Essex and Co.

Fig. 10. "The Scroll Frieze." Designed by T. R. Spence. Printed by Messrs. Essex and Co.

Fig. 11. "The Syon." Designed by T. R. Spence. Printed by Messrs. Essex and Co.

Fig. 12. "The Twickenham." Designed by T. R. Spence. Printed by Messrs. Essex and Co.

Fig. 13. "The Tinnevelly." Designed by T. R. Spence. Printed by Messrs. Essex and Co.

Fig. 14. Example of wall-paper made in 1840.

The stencil papers on the walls were exhibited by Messrs. Hayward and Sons.

DISCUSSION.

Mr. FREDERIC AUMONIER said he should have been very glad to have had more information as to stencilling. His experience with stencilling was that they did not get anything like the same accuracy or rapidity of production as in the case of printing. By the latter process they could secure a certain amount of regularity in the application of the colour, which prevented the paper when hung from showing marks and bad lines at the joints. When stencilling was applied to wall-paper, which was afterwards hung in breadths, it was always found that there was a bad line, in consequence of the stencilling not giving the same tone of colour at each side of the breadth. That was a difficulty which did not exist in the case of printing. No doubt, by stencilling you could get extremely artistic effects, which it was impossible to obtain by printing. In the case of solid panels, friezes, or spandril decorations, where the ornament was not repeated a number of times, and placed upon a flat surface, you could vary the colour and form, if needful, to a great extent, which it would be quite impossible to do by block printing, or rather impracticable, owing to the form of the blocks. It was impossible to produce a number of blocks to obtain a variety of colour over an extended surface or variety of forms; and makers were obliged to content themselves with comparatively modest proportions in the work done. They did sometimes get two, three, or four sheet-blocks, and they might vary the colour; but they had to be careful to keep the colour at the edges of the paper so evenly balanced, that when it was hung in breadths, there should be no fault found with it through bad lines.

Mr. WITHERING, referring to washable sanitary papers, said many persons thought that the most artistic effect was produced in these papers; and, for his own part, he certainly thought they compared favourably with surface printing. Speak-

ing generally on the question, he thought that manufacturers had much to be proud of in the position which they held for wall-papering. For the last 10 or 20 years, English manufacturers had made great and rapid strides in designs, and colouring, and workmanship, in regard to paper-hanging. Looking at the many excellent designs exhibited that evening, he was led to think that but very few of them would ever find their way into the homes of the British public, and beautify their dwellings, at the expense of a few shillings. He regretted very much that Mr. Spence had omitted all reference to sanitary wall-papering. Personally, he felt a little bit sore that so many designs now came from France, and he hoped that English manufacturers would take this more to heart.

Mr. C. F. A. Voysey said the suggestion that designers should design down to the taste of the multitude who liked washable papers was a most deplorable one. It was demoralizing to a designer to do any but his best work, and no one was justified in assuming that a man's best work would not be appreciated as much as it deserved. It would be better for manufacturers to co-operate with designers, rather than designers with manufacturers. Mr. Voysey heartily endorsed all that Mr. Spence had said on matters of taste, and had listened to his paper with very great pleasure.

Mr. Metford Warner thought manufacturers were not going back to the period of rococo, or copying French designs, but were determined to show that they could design something superior to anything that came from France. Sanitary and washable papers belonged to a cheap and nasty age, and as a result were successful. The design of these papers was, as a rule, very poor, and the effect upon the wall was not good. The very process employed in their manufacture necessitated that the printing-rollers should be just the same as in cotton prints. For artistic merit he considered English manufacturers would always hold their own. The specimens of stencil work before them were specially interesting, and showed what had been done by combination of the two processes.

Mr. Howe quite agreed that sanitary papers were most inartistic, but he thought it might be possible, by the use of some vehicle or pigment, to make the ordinary paper-hanging spongeable, such, for instance, as by leaving out the size. If this were possible, they might have for the surface such decorative material as would be a very healthful material.

Mr. Warner said this could be done, and at present was done.

Mr. Hugh Stannus begged leave to thank Mr. Spence for his paper. He confessed that he had been a little disappointed with it. The author had spoken eloquently about the artistic decorations in Italy, but the title of his paper was "Wall-papers and Stencilling;" and stencilling had been disposed of in a quick and incomplete manner. Mr. Aumonier, as representing one of the oldest firms of paper-stainers in England, had objected to the use of stencilling in papers while they were in course of manufacture, and he (Mr. Stannus) entirely agreed with him. They knew that when patterns were stencilled in distemper colour there was often a little ridge all round, which was detrimental to decorative effect. He had seen stencilling done after the paper was hung on the wall, but that, of course, was rather the business of the artistic decorator than of the paper-stainer. The operation of stencilling gave a matted or dead effect. If it be painted by means of a brush the very dragging of the hair of the brush over the surface produced a gloss upon it, which spoiled the effect. When it was necessary to add enrichment to the paper, he certainly advocated stencilling for the purpose. A few birds or animals, judiciously stencilled on the paper across the joint, had a marvellous effect of enriching the design and disguising the repeat whenever that was desired. Mr. Spence, probably in consequence of slurring over the question of stencilling, had omitted to allude to an extremely interesting book of Japanese Stencil-patterns which had been lately published, which he (Mr. Stannus) would strongly advise all pattern-artists to study. He could corroborate what had been said about the English and French designs, compared together at the last Paris Exhibition. While there for some time he had made it his business to compare English applied art with French in all branches; and he was struck with the fact that while, with one exception, the French designers appeared to be merely re-cooking their own byegone styles from Louis XIII. to their Empire style (which was archæology rather than art), there was a freshness about the English designs that bid fair to be hereafter acknowledged as an English style, especially in wall papers.

Mr. G. Haite said this was a subject which he was proud to say he had identified himself with to a considerable extent. Recently he had taken to landscape painting, and in more than one paper it was stated lately that in the early part of his life he devoted himself to decoration, but had lately determined to be an artist in the fuller and higher sense—not to be a designer simply, but an artist. That expression did not meet with his concurrence or sympathy, but it only showed how more was to be learnt still by the public as to what an artist was. If he knew anything of the art in which he was indulging, he had learnt it entirely from studying decorative art. The paper to which they had listened was extremely interesting and full of matter for reflection. Some years ago he delivered a lecture on the subject, giving the origi

d introduction of wall-papers into England, and : present paper had taken up the subject from where left it, and carried it on. Mr. Spence had said :y should remember that design was not adaptation ly, but there he would take issue with him, for it :med to him to be the only reason for its existence. on the other hand, painting as a phase of art, ght indulge in all manner of extremes, but a design s worthless unless it was suitable for the purpose which it was intended. With regard to the servation of Mr. Spence as to the lamentable craze French work, he thought this arose rather from desire for novelty, and the dictates of fashion iich, to their credit, were to a considerable extent iored by manufacturers. Designers were in-bted to manufacturers in this respect, and, for own part, he might say he had always received : greatest kindness and consideration at their hands. was chiefly owing to this fact that he had remained long in designing, when his strong instinct was to nt landscapes. Stencilling was a very valuable de of decoration, but he did not think it was suit-e for paper during its process of manufacture, ugh it might be employed more than it was upon paper after it had been placed upon the wall. He te agreed that the true artist should never be amed of repeat; but in a wall-paper the space to covered was a flat one, and must be decorated as h. If the conditions of repeat were not given the st careful consideration, no matter how fine the tern might be in itself, the paper, when hung, uld be unsatisfactory. In a certain sense, they had humour that. Mr. Spence said the aim of wall-per decorations was not realism. It would be icult for him to accept any phase of art that had h an aim. It was the element of the ideal that gave rt the right to be considered artistic. If, as artists, y sought to vie with nature, they courted compari-, and the result, as they deserved, was disastrous themselves.

Ir. R. W. Essex said, with regard to painting designs, nufacturers were hampered and fettered to a great ent by the market, and by the criticisms offered the market. While it might seem a confession of vardice on the part of the manufacturers to urge h a plea in self-defence, yet, on the other hand, nufacturers could not be expected to be wholly un-idful of that by which they lived. For instance, they that a design was not to be condemned simply solely on the ground that the construction was apparent to the eye, yet when it was issued they e met with the remark, "I can count that." n manufacturers tried to boil that criticism down what it was worth, by suggesting all that might be in favour of the appearance of the repetition, but ently they were met with the remark, "I cannot g pictures on the paper, simply because there is a se of mutilation." When artists urged there ld be no harm whatever in the manifestation of the struction of a design, manufacturers on their side were compelled to urge, in extenuation of their refusal to admit the design in their lists, what they thought to be a defect in it, so far as the market was concerned. A great deal had been said about French designs, and in this respect again manufacturers were somewhat fettered and hampered. There was hardly a man in the trade who sold most freely exactly what he liked best. He should like to hear if anybody could fix the date when that millennium was coming, when the things they loved most would be taken up by the British public. He abhorred sanitary wall-papers, though he must admit that he sold a great many of them. He never sold them without a protest, yet, forsooth, as a man of business, he must admit that if the public would have them, he could not refuse to supply them. As a question had been asked whether some vehicle could not be used of a more artistic character, he might say this was rendered impossible, by the process of manufacture, the rollers being finely engraved, and in order to get the delicate gradation of shade and colour, the colours had to be ground down exceedingly fine, and it became impossible to use any of the coarser materials which gave a better decorative result. At present, the manufacturers of papers by the so-called sanitary process, must be governed and fettered by the very vehicles employed. As to getting designs from France, his own opinion was that manufacturers were now getting very few designs from this source. He should be glad to have had a little more light thrown upon the delicacy of stencil work in wall-paper printing. There were some beautiful examples of the work upon the wall, but in them the difficulty seemed to have been rather evaded than met. There were many fine friezes which were made by a combination of stencilling and printing, but it would be impossible to get anything like that rich gradation of colour and sense of form in the mere mechanical processes to which they were compelled to resort. Something might be done by inserting stencil in such portions of the design as should not lay them open to the difficulties which manifested themselves when the cut portion was brought edge to edge.

Mr. Cowan said he was not an artist-designer or paper-stainer, but he had, for some considerable time, been connected with the wall-paper trade generally. He thought the paper of Mr. Spence contained many points which would enable manufacturers to remedy many of the defects which at present existed. Mr. Spence seemed to imply that there was a lack of high technicality in connection with the colouring of wall-papers, that there was room for development both with regard to harmony and the consideration whether the repetition of a paper might be to some extent hidden, and the repeat toned down by a more careful consideration to the tinting to the paper. Where a decided and distinct pattern could be seen by the eye, it became, in course of time, somewhat obnoxious, but if the colours had been toned down, that

would not have been so perceptible. With regard to English wall-paper manufacturers, no doubt there were many considerations which individual manufacturers would look upon as belonging to themselves; but, in moving about the various parts of the world, he had been asked why there was no uniformity or system whereby English goods might be sent into other countries, and classed alongside the manufactured goods of that country, and sold at something like an English equivalent. In Philadelphia, he once asked a manufacturer why he had no English wall-papers in stock, and was told that they could not be sold, owing to their being 12 yards, against the American 8, which fact purchasers seemed to overlook when the question of price was concerned. English manufacturers would do well if they considered whether their trade would not be increased by adopting one standard. Washable papers had been a great service to people who could not afford to buy Lincrusta, but it was not wise at all times to ignore the market into which their wares went. He did not think sufficient consideration was shown by wall-paper manufacturers towards technical education in connection with house decorators. If anyone had seen the influence that a foreman painter could wield with a client in selecting wall-paper, they would see that it would be wise to educate the taste of the decorator somewhat.

The CHAIRMAN said there were one or two particulars in which he might supplement the paper. Mr. Spence had said there was no reason why they should not use in wall-papers more primaries, and have less dirty tints. This was quite true, if they were allowed to use an unlimited number of printings, but they could not do so. Mr. Spence himself said that wall-paper printing should be simple. When you are printing in distemper, you have very crude and unmanageable colours to deal with; and it was impossible to get beautiful and soft effects without a number of printings. The printing in low colours was an absolute necessity, if you wished to print in a few colours, and get a subdued effect. With regard to stencilling, he thought that, although stencilling might be made use of in addition to printing, this was mixing two processes, which he rather disliked, beautiful as some of the results of so doing might be. The process only adapted itself to friezes. If you were going to stencil, you had better stencil altogether. In Italy they used stencilling absolutely instead of wall-papers, and in some of the hotels there he had often noticed what looked at first sight like a most imposing paper, which, upon closer investigation, turned out to be stencilling; and this, he was told, was executed at very low cost. In Italy they could stencil a wall with a gorgeous damask pattern much cheaper than we could print it. He protested strongly against the use of gold in wall-papers, except they were lacquered. Manufacturers would no doubt admit that it was only introduced for commercial purposes. He did not agree with Mr. Spence when he said that ornamentists ha not given us better forms of ornament than painter There he had fallen into the common error of su posing that because a man could do one thing could do another—because he could do the great thing he could do the less, which did not follow all. With regard to the Italian painters mentione he did not remember anything very special in the w of actual ornamental invention. Their ornamen design, so-called, consisted chiefly of reproducti of antique work. In the case of Holbein, who w a master of ornament, his ornament, when wo anything, was made up of the figure. In the case the very room at Mantua, mentioned by Mr. Spen it was not known by whom it was done; work w often attributed to painters who had had nothing do with it. A painter, as such, was not necessa competent to design ornament. If he wanted to that he would have to go to school, both with ornamentist, and with the manufacturer. For own part, he had learnt an enormous deal from t manufacturer; if he knew anything about the pr tical part of designing for wall-papers, it was mai due to his friend Mr. Warner. In conclusion, he p posed a hearty vote of thanks to Mr. Spence for admirable paper.

The resolution was unanimously agreed to.

FOREIGN AND COLONIAL SECTIO

On Tuesday evening, 28th February, EDWARD BRADDON, K.C.M.G., read a pa on "Russia as a Field for Tourists." Mr. M. KENNEDY, C.B., presided.

The paper and discussion will be printed the next number of the *Journal*.

TWELFTH ORDINARY MEETING

Wednesday, March 1, 1893; Captain DE W. ABNEY, C.B., F.R.S., in the chair.

The following candidates were proposed election as members of the Society:—

Adam, Sir Frank Forbes, C.I.E., Alderley-e Cheshire.
Bhagranani, M. S., B.A., Khairpur, Sindh, Indi
Bristow, John Griffin, M.A., 1, Copthall-buildi E.C.
McCoy, M. P., 54, Farringdon-road, E.C.
O'Driscoll, Florence, M.P., 18, Gower-street, W.

The following candidates were balloted and duly elected members of the Society:—

Hopkins, Thomas John, Cradle-bridge Wo Trowbridge, Wilts.
Murzban, Khan Bahadur M. C., C.I.E., Bom India.

kudder, G., 12, Belmont-park, Lee, S.E.
hompson, Harry J., Arkonan, Madras, India.
'atson, F. T. G., M.Inst.C.E., C.I.E., Lucknow, India.

The paper read was—

TELE-PHOTOGRAPHY.

y Thomas R. Dallmeyer, F.R.A.S., &c.

The object of "Tele-photography," as its ıme signifies, is the production of photo-aphs of objects situated at such distances om the operator that they can be interpreted ıd examined in a manner that would be ıpossible to the naked eye. The term is ırallel in its meaning with "Telescopy," and le-photography has as its aim the recording a photographic plate a combination of a ımber of distinct and separate telescopic ıpressions that can be obtained by sweeping telescope over a greater field than that cluded in its own field of view, in the same ınner, but to a less degree, that ordinary otographs record a number of distinct and parate visual images or impressions obtained passing the eyes rapidly, and almost un-nsciously, through the "wide" and "deep" lds of view, as they are termed.

When we view any object with the naked e, we judge of its apparent magnitude by angle which it, or any two points in it, pear to subtend at the eye, or point of sight. we approach the object the angle sub-ıded becomes greater and the object becomes gnified, and *vice versâ*. The ordinary gnifying glass enables one to see an object der a greater angle than without its use; in case of the microscope, we are enabled to a much nearer approach with the lens to object than would be possible, with distinct ion, to the eye itself. In viewing an object h a lens, the apparent magnitude, as seen ough the lens, is to that with the naked as the distance of the object from the eye o the focal length of the lens.

The foundation principle of the telescope ts again on the possibility of seeing objects ler a greater angle than that possible with naked eye. Knowing that the apparent gnitudes of objects vary inversely as their tance from the eye, it is evident that if we n a real image of any object by a lens, l place the eye in the position of the optical tre of the lens, that both object and image ıld subtend equal angles, and therefore be the same apparent magnitude. Now, a rer approach of the eye to the image enables one to see it under a greater angle, and it therefore becomes magnified. In the telescope, as you are aware, this real image, although formed in air, is magnified again by the eye-piece, the magnifying power of the telescope being the focal length of the object glass divided by the focal length of the eye-piece. This holds good in all types of telescopes—astronomical, terrestrial, or Galilean. It is well to note here that an increase in the length of focus of the object-glass with a constant eye-piece, or the employment of an eye-piece of shorter focus with a definite length of focus for the object-glass, will alike bring about increased magnifying power.

In leading up to the subject before us, it will be best to first grasp the full significance of magnifying power in the use of telescopes. The power really means that you approach (according to the power employed) so many times nearer to the object, and this explains how it is that the "fixed stars" do not appear larger (although more brilliant) in the telescope for the approach of a few hundred or even thousand times nearer is so insignificant an approach compared to their immeasurable distances from us, that we cannot appreciate any increase in the angle these bodies subtend, any more than we could appreciate the difference in the angle subtended by some familiar object, say a mile or two off, and the same object viewed from a point of sight only a yard or two nearer!

The usual practice in astronomical observations is to increase the power of a telescope by employing an object-glass of definite focus with sets of Husgenian eye-pieces ranging from longer to shorter foci used in conjunction with it, the limit of magnification being determined mainly by the sufficiency of light transmitted to the eye to enable it to be seen. When, however, the telescope is employed for micrometrical measurements, another well-known form of eye-piece, the "Ramsden," has to be employed, as it is necessary to have both the primary image given by the object-glass and the wires in the same plane. Now, it is evident that any increase in a series of higher power (or shorter foci) Ramsden eye-pieces would not only increase the magnification of the telescopic primary image, but also increase the apparant thickness of the wires themselves.

In February, 1834, George Dolland, F.R.S., made a communication to the Royal Society in which he gives an account of a "Concave Achromatic Glass Lens, as adapted to wire micrometers when applied to a telescope,

which has the property of increasing the magnifying power of the telescope without increasing the diameter of the micrometer wires." The achromatic concave lens was first made at the suggestion of the late Professor Barlow, "for the purpose of improving the chromatic aberrations which affected the field of the eye-glasses applied to the telescope, invented by that gentleman, with a fluid correcting lens." To George Dolland belongs the credit of applying Barlow's lens to the telescope to attain greater magnification at the primary focus by interposing such a negative lens between the object-glass and the eye-glass, and thus enabling a lower power eye-piece to be employed upon the micrometer wires, and yet attaining a greater magnification than the object-glass alone would give.

In this communication (1834) George Dolland says, "The interposition of a concave lens between the object-glass and eye-glass of a telescope has been generally known by opticians to produce an increase of the magnifying power, in proportion to its focal length and distance from the object-glass: also that a convex lens, if so applied, would diminish the power." This statement, although made sixty years ago, is not surprising, as the oldest works on optics contain the very simple formula (that I shall shortly trouble you with for a few moments) connecting lenses of various foci and their separation. In May of the same year Peter Barlow further dwelt on the advantages that might accrue from employing his negative lens in "day telescopes," and also for astronomical telescopes where the micrometer is not employed, "for by giving an adjustment to the lengthening lens the power may be changed in any proportion, even without removing the eye or losing sight of the object. I have no doubt these and other applications of the lengthening lens will be made."

Barlow's rough directions for making the negative achromatic lens were to make the plate or crown lens concave instead of convex, and the flint convex instead of concave.

Having examined the known methods of attaining magnification in the virtual images as seen through the eye-pieces of telescopes, we will now proceed to an examination of the production of real images, that are necessary in photography, and the methods of enlarging those images before they are received upon the photographic plate.

Every positive lens or lens-system forms a real image of an object in the plane of its focus. The focal length of a lens is measured by the distance between one of the princip[al] planes pasing through one of the nodal poin[t] of the lens towards the principal focal pla[ne] (where the image is received) and that plan[e]. The size of the image of any distant object [is] dependent on this measure of the focal lengt[h] and in comparing two lenses, no matter [of] what form of construction, if the size of t[he] image given by one is n times that of t[he] other, you are aware that the focus of the o[ne] is n times that of the other. In order then [to] attain larger images of distant objects, phot[o]graphers, until quite recently, have only h[ad] recourse to the employment of ordinary po[si]tive systems of greater length of focus th[at] necessitated the use of unwieldy apparatus.

Another possible method of attaining [an] enlarged image has been the application [of] the telescope itself to the photographic came[ra] in the cases of the astronomical and terrestr[ial] telescopes the eye-pieces acting as seconda[ry] magnifiers, and in the case of the Galile[an] telescope, the negative lens acting as a pow[er]ful "Barlow." These applications have m[et] with but little success, first, on account of t[he] very small angle included, and, secondly, [on] account of their extreme slowness. They ha[ve] been applied chiefly and almost entirely [to] solar observations, either by projecting t[he] image of the sun on to a screen in order [to] make it visible to a number at once, or pho[to]graphing it by placing a sensitive plate in t[he] place of the real image upon the screen.

In observatory work, special instrume[nts] have been designed from time to time by [my] late father and myself, known as "Pho[to]heliographs," in which the primary so[lar] image is magnified by specially-construc[ted] "secondary magnifiers" in order to attain [as] flat a field as possible in the photograp[hic] image, and a perfect coincidence of the vis[ual] and chemical foci. In the forthcoming Ecli[pse] Expedition a new enlarging negative le[ns], photographically corrected, will be emplo[yed] as a trial of the comparative advantages [of] the two systems. The system of adoptin[g a] secondary magnifier, in ordinary photograp[hy], has been tried; but little has been heard o[f it] as the field is very small, the illumination [of] the image weak, and the image itself er[ect], which is usually a disadvantage.

In the autumn of 1891, I first directed [my] attention to the lens I termed, "The T[ele]-photographic." The problem was to (1) c[on]struct a lens giving large direct (and inver[ted]) primary images of sufficient rapidity, c[on]sistent with covering power, and including [in]

gle large enough to be of value in, and an vance upon, the methods already in use; d (2) to reduce the bulky and unwieldly paratus formerly necessary.

In principle it is identical with Dolland's aptation of Barlow's lens for increasing the :al length, and, accordingly, the magnitude the image, without materially lengthening ; length of telescope tubes.

The preliminary difference in detail, how-er, consisted in the adoption of a positive ment of large aperture and short focal igth (or high intensity as it is called), and a gative fractional in its focus of the positive, is enabling the elements to be contained in short tube. In this manner a considerable ignification is attainable, and a useful iount of angle can be included. The further ference lies in the fact that Dolland and rlow had only to attend to the corrections their central pencils, and in my first en-avour to produce this photographic lens, it s necessary to construct an optical system which both central and excentrical pencils ould be properly corrected throughout a : field, in addition to being actinic or emically corrected. This construction I ill briefly refer to. The positive aplanatic s, A, can only be corrected to define in its s the appearance of the image of any ect a little way off the axis being indistinct; vas necessary then to calculate the curves the lens, B, of the most suitable form to rect the entire instrument throughout its d. To enter into the niceties of lens con-uction it can easily be shown that with this m of lens system there can be only one inite extension of camera or distance be-en B and P L, in which the entire system is anatic. Again, this form of lens produces violent a pincushion distortion to be admis-le, and I, therefore, discarded it for a more ent construction that I will shortly illustrate, which one error is remedied, and the other nimised. On account of the fewer number elements in this more simple form, I will e utilise Figs. 1, 2, and 3 (p. 382) to describe general principles involved in the working the tele-photographic lens.

'or the purpose of forming an image for given position of the focussing screen, rays must be made convergent, producing irect primary inverted image.

t is immaterial what position may be chosen the plane upon which the image is to be eived; it may be either in close proximity the posterior lens, or removed to any distance whatever further away; but in order to focus, it is essential that a correct distance be given between the two elements of the lens itself; in other words, a correct adjustment of their separation, focussing always being most easily, and sometimes necessarily, accomplished in this manner (Fig. 1). For example, supposing the lens were focussed upon a very distant object—say the sun—with the focussing screen set at a given distance, it would be impossible by any adjustment whatever of the focussing screen to find a plane where the instrument would come to focus for very near objects (Fig. 2).

The upper black ray meets the lens A parallel to the axis, and by a proper adjustment between A and B, comes to the focus at F upon the plate P L. If P L be removed further from the lens B to take the position P′ L′, the lens A will have to be moved slightly nearer to B and take the position A′.

The lower dotted line represents a parallel ray falling upon A′, which passes through the negative lens B, and coming to focus upon the new position of the plate P′ L′, at F′.

On the upper side of the axis a parallel ray to A finds its focus as in the dark line on the plate at F. If, however, some ray from a near object falls upon the lens A in the direction of the dotted line, after passing through the lens B, is found divergent, and no positive focus is obtainable.

In the lower half of the figure, however, A is presumed to take a proper position in A′ when the ray from the near object passing through A′ and also through the negative lens B finds its focus upon the plate in the fixed position chosen, at F.

Near objects with the lenses in their former adjusted or fixed position would send the rays from such objects, after passing through the entire lens, divergent and not convergent.

On the other hand, if the separation were adjusted between the two elements for a near object, and it was then pointed towards a distant object, it would be found equally impossible to find any position for the focussing screen, in which the focus could be observed, except as before stated by an alteration between the separation of the component elements of the lens itself.

It is evident that the longer the focus of the positive element in the construction, the greater would have to be the separation between the two elements for near or distant planes.

In this construction there is then no limit to the size of the image that can be obtained, a

FIG. 1.

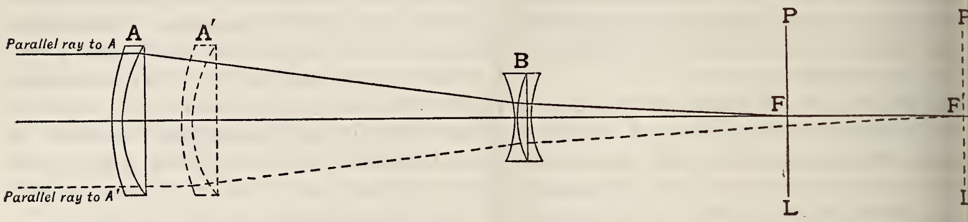


FIG. 2.

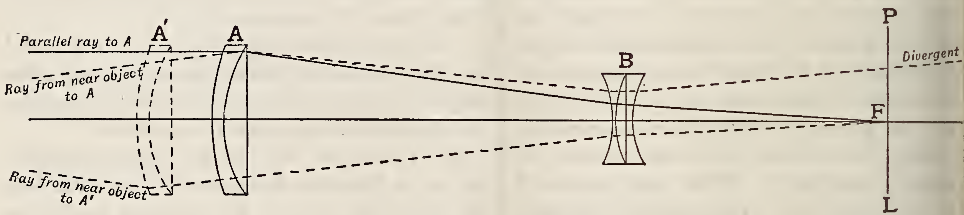


FIG. 3.

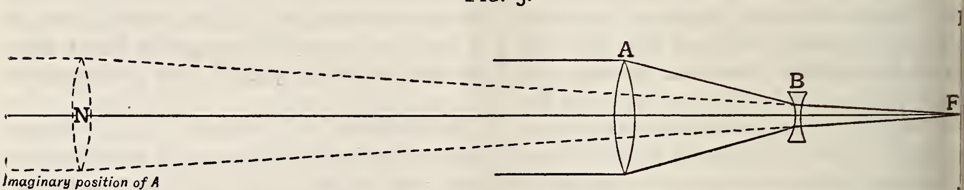


FIG. 4.

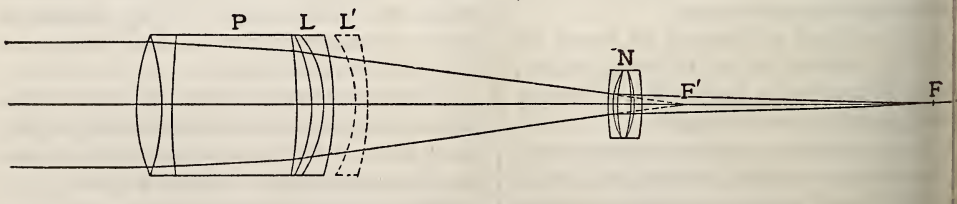


Fig. 5.

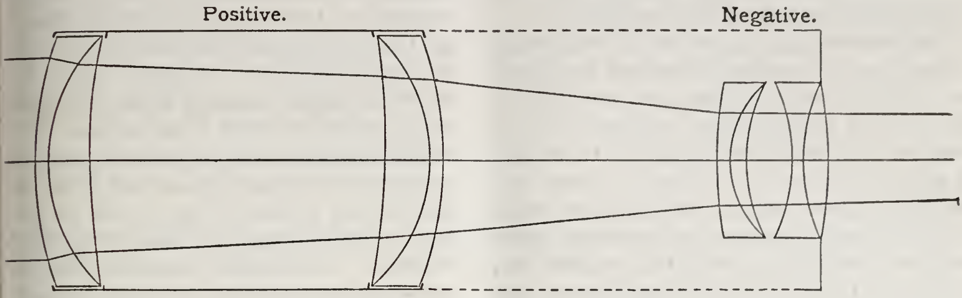


Fig. 6.

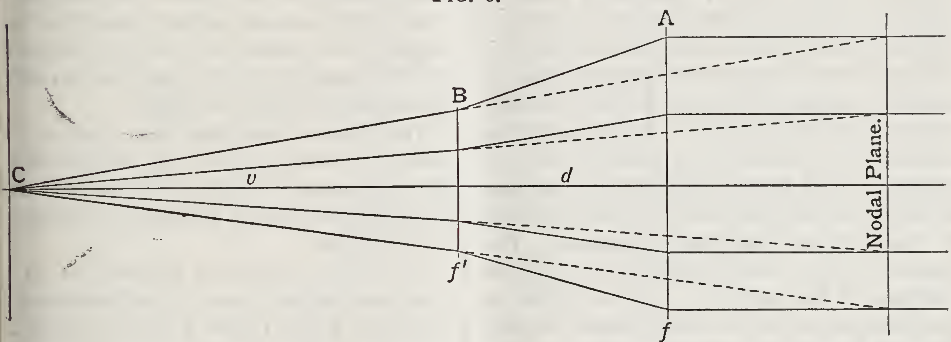
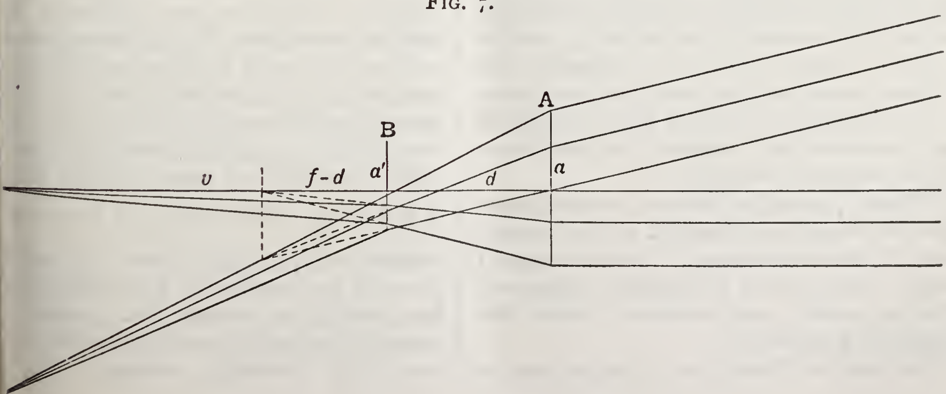


Fig. 7.



slight adjustment in the separation of the two elements producing the correct focus on the screen, be it near or distant from the lens itself; but it must be borne in mind that the greater the separation between the plane of the focussing screen and the lens, the less is the rapidity that can be attained (Fig. 1).

I will now call your attention to the question of rapidity. Supposing the screen be placed at a distance of 10 inches from an ordinary lens, and a distant object focussed, say the lens has a focus for parallel rays of 12 inches, if the new lens be made to take its place, and the same object be focussed, it will be found that the image produced is five times larger with the new lens than with the ordinary one, you know then that you are practically, and to all intents and purposes, employing a lens of 60 inches focus!

The question naturally asked is, What will be the rapidity? The answer is, that you have to consider the front lens placed at distance of 60 inches from the focussing screen; in other words, the nodal point is thrown forward outside the lens to a distance of 60 inches from the focussing screen (Fig. 3).

Represents a beam of rays passing through the two component elements, A and B coming to focus upon the plate P L. To estimate the rapidity it is necessary to consider the full aperture placed at the full focal plane passing through the nodal point at N; A is thus made to take up an imaginary position. The position of the nodal changes for different positions of the plate P L. It is evident to you then that too much stress cannot be laid upon the desirability of large aperture for the anterior positive lens.

In the case cited, supposing the lens to be of 3 inches aperture, you would then be working at an intensity of $f/20$.

In the improved form of tele-photographic lens (Fig. 4, p. 382), the positive element consists of a complete portrait combination, preferably of the form invented by my late father, and the negative element is a double combination with exterior convex surfaces, but of negative focus.

The portrait combination must be rapid (of large aperture) and preferably of short focus, on the score of portability.

This is corrected to the best possible degree in itself throughout the field, and so again is the "negative rectilinear." By this means I attain better quality of definition throughout the entire field, and, moreover, reduce distortion to a minimum.

The form of portrait lens employed has the means of separating the fourth (flint) lens from the third (crown) lens. If the portrait lens be used alone it will be noticed that if the flint be slightly separated from the crown that the image becomes "softened" or less sharp through the introduction of positive spherical aberration. In tele-photography we desire to get the utmost definition possible, and with the greatest amount of light, and I have utilised this form of lens to attain the opposite end for which it is used in portraiture. If the tele-photographic lens be focussed upon, and corrected for a near object, and it be then focussed for a distant one, it will be found that negative spherical aberration will be observed. By slightly separating the back lens from its neighbour the requisite amount of positive spherical aberration can be introduced to obliterate the negative spherical aberration, and the image becomes perfectly sharp. Unless the corrections of the positive element be variable, no form of tele-photographic lens could be made to give sharp images for all planes and different extensions of camera without resort to small stops, that in themselves not only materially affect the rapidity of the lens, but also reduce the amount of subject included.

The efforts of opticians have been and are being continually put forth in the direction of the attainment of large angular aperture combined with as near an approach as possible to a "flat field."

Now if the portrait or positive lens in the tele-photographic lens is well corrected for flatness of field, in itself it will be found that there is a tendency to the *reversed curvature* of field to that which obtains in all ordinary rapid lenses. This tendency may be advantageous or disadvantageous, but is best removed, if possible, and this I have succeeded in doing. The cause of the defect is not far to seek, in that the excentrical rays passing through the negative combination are lengthened more than the central ones. Nor is the remedy a difficult one, it consists in giving a greater curvature of field to the positive element. This is done by special constructions, such as I show you in Fig. 5 (p. 383) (corrected for parallel rays), in which the rapid positive element $\frac{F}{3}$ has an impossible amount of curvature for ordinary work, *i.e.*, used alone. In combination with the negative as a tele.photographic lens, the field is perfectly flat. Another and temporary method is to rob the portrait lens of one of its flattening elements, viz., the

ements of separation, by placing the lenses a shorter tube; when used in conjunction ith the negative combination as a tele-photo-aphic lens the reversed curvature dis-)pears, and the instrument is more portable id somewhat more rapid.

For practical purposes it has been found est to construct a Table of references showing r different extensions of camera from the ick lens—(1) the corresponding foci (2) the intensity at full aperture, and (3) the circles of illumination with the full aperture, and also the smallest stop. After the intensity at full aperture, the diaphragm apertures are arranged so that each succeeding smaller one requires double the exposure of the previous one. When the circles of illumination are known, it is easy to determine the current sizes of plates that can be covered without cutting off at the corners.

ANGLES INCLUDED, CORRESPONDING FOCI, AND CAMERA EXTENSION.

Distances of Focussing Screen from Compound Negatives or Back Foci (1.)	No. 1. Angle included is practically constant, at full aperture equals 11°. 3 (2)			No. 2. Angle included is practically constant, at full aperture equals 12°. $3\frac{1}{5}$ (2)			No. 3. Angle included is practically constant, at full apertnre equals 9°. $2\frac{2}{3}$ (2)		
	Corre-sponding Foci.	Intensity at Full Aperture.	Circle of Illumina-tion at Full Aperture.	Corre-sponding Foci.	Intensity at Full Aperture.	Circle of Illumina-tion at Full Aperture.	Corre-sponding Foci.	Intensity at Full Aperture.	Circle of Illumina-tion at Full Aperture.
Inches.									
....	$17\frac{1}{2}$	$\frac{1}{11}$	$3\frac{1}{2}$	20	$\frac{1}{10}$	$4\frac{1}{4}$	—	—	—
....	21	$\frac{1}{13}$	$4\frac{1}{2}$	$22\frac{1}{2}$	$\frac{1}{11}$	$4\frac{3}{4}$ $3\frac{1}{4}\times3\frac{1}{4}$	—	—	—
....	24	$\frac{1}{15}$	$5\frac{1}{4}$ $3\frac{1}{4}\times3\frac{1}{4}$	25	$\frac{1}{12\cdot5}$	$5\frac{3}{4}$ $4\frac{1}{4}\times3\frac{1}{4}$	34	$\frac{1}{12\cdot4}$	$5\frac{1}{2}$ $4\frac{1}{4}\times3\frac{1}{4}$
....	30	$\frac{1}{19}$	$6\frac{3}{4}$ 5×4	$31\frac{1}{2}$	$\frac{1}{16}$	$7\frac{1}{2}$ 5×4	$42\frac{1}{2}$	$\frac{1}{15}$	7 5×4
....	36	$\frac{1}{22}$	$8\frac{1}{4}$ $6\frac{1}{2}\times4\frac{3}{4}$	37	$\frac{1}{18\cdot5}$	$9\frac{1}{4}$ $6\frac{1}{2}\times4\frac{3}{4}$	$47\frac{1}{2}$	$\frac{1}{17}$	$8\frac{1}{2}$ $6\frac{1}{2}\times4\frac{3}{4}$
....	42	$\frac{1}{26}$	10	45	$\frac{1}{22\cdot5}$	11 $8\frac{1}{2}\times6\frac{1}{2}$	$56\frac{1}{2}$	$\frac{1}{20}$	10
....	48	$\frac{1}{30}$	$11\frac{3}{4}$ $8\frac{1}{4}\times6\frac{1}{2}$	50	$\frac{1}{25}$	$12\frac{3}{4}$	63	$\frac{1}{23}$	$11\frac{3}{4}$ $8\frac{1}{2}\times6\frac{1}{2}$
....	54	$\frac{1}{33}$	$13\frac{1}{2}$ 10×8	57	$\frac{1}{28\cdot5}$	$14\frac{1}{2}$ 10×8	71	$\frac{1}{26}$	$13\frac{1}{2}$ 10×8
....	60	$\frac{1}{37\cdot5}$	15	$62\frac{1}{2}$	$\frac{1}{32}$	$16\frac{1}{4}$ 12×10	78	$\frac{1}{28}$	15
....	—	—	—	69	$\frac{1}{35}$	18 13×11	85	$\frac{1}{30}$	$16\frac{1}{2}$ 12×10
....	—	—	—	76	$\frac{1}{38}$	$19\frac{3}{4}$ 15×12	92	$\frac{1}{33}$	18 13×11
....	—	—	—	84	$\frac{1}{42}$	$21\frac{1}{4}$	100	$\frac{1}{36}$	20 15×12
....	—	—	—	—	—	—	106	$\frac{1}{38}$	$22\frac{1}{4}$
....	—	—	—	—	—	—	114	$\frac{1}{40}$	$24\frac{3}{4}$ 18×16
....	—	—	—	—	—	—	124	$\frac{1}{45}$	27
....	—	—	—	—	—	—	$157\frac{1}{2}$	$\frac{1}{00}$	42 30×24

The calculations necessary to arrive at these sults are of a simple character, and are there-e given in the hope that they may prove useful.

In Fig. 6 (p. 383), let $f\,f'$ be the (numerical) cal lengths of the positive and negative ele-ents, A and B, v the back focus, d the distance etween the negative element and the nodal int of positive element, F the equivalent cal length of the combination. Then the agnification, defined as the ratio of the iear dimensions of image given by the mbination: dimensions of image given by sitive element alone, and calling this

$$\text{M}, \quad \text{M} = \frac{\text{F}}{f}.$$

$$\text{Now} \quad \frac{1}{v} = \frac{1}{f-d} - \frac{1}{f'}$$

$$\therefore \quad v = \frac{f'(f-d)}{f'-f+d} \text{........ (Back focus.)}$$

$$\frac{1}{\text{F}} = \frac{1}{f} - \frac{1}{f'} + \frac{d}{ff'}$$

$$= \frac{ff'}{f'-f+d} \text{...... (Equivalent lens.)}$$

These two formulæ and their interpretation, when applied to different types of lenses, have been neatly tabulated in a paper contributed by J. Brown, B.Sc., C.E., to the Philosophical Society of Glasgow, in a paper, "On some elementary facts regarding the foci of lenses, with special reference to Dallmeyer's new tele-photographic lens," April 13th, 1891. This I reproduce in next column.

Steinheil's antiplanat is included as one of the elements—is slightly negative in focus, although a fixed system. Petzval's orthoscopic is probably omitted through an oversight; in this case, the negative element is about twice the focus of the positive element. The back focus in this case is slightly less than the equivalent focus. The quantity, d, is not convenient to measure, we shall, therefore, substitute for it in terms of v.

Thus

$$\mathrm{M} = \frac{v}{f - d} = v\left(\frac{1}{v} + \frac{1}{f'}\right)$$

$$= 1 + \frac{v}{f'}$$

$$\mathrm{F} = f\left(1 + \frac{v}{f'}\right) = f\mathrm{M} = f\left(1 - \frac{b}{f'}\right) + \frac{\mathrm{E}f}{f'}. \quad \ldots. \ (1)$$

The negative element is fixed at a known distance inside the flange, if b is the distance from flange to negative element, and E extension of camera from flange to ground glass,

$$v = \mathrm{E} - b$$

and the magnification of the image compared to a single lens with the same extension of camera is plainly

$$\mathrm{M}' = \mathrm{M}\frac{f}{\mathrm{E}} = \frac{f}{f'}$$

nearly, if the extension of camera be considerable, but

$$= \frac{f}{f}\left(1 - \frac{b}{\mathrm{E}}\right) + \frac{f}{\mathrm{E}} \quad \text{accurately} \ldots. \ (2)$$

If I represent the intensity of positive element,

$$\text{Intensity} = \frac{\mathrm{I}}{\mathrm{M}} = \frac{\mathrm{I}f}{\mathrm{F}} \ldots\ldots\ldots\ldots\ldots\ldots\ (3)$$

Next, as to the size of plate covered at and given intensity. Referring to Fig. 7 (p. 383), the diameter of the circle beyond which no light can pass being called D, and the apertures of the positive and negative elements a and a' respectively

$$\frac{\mathrm{D} - a'}{v} - \frac{a + a'}{d} = \frac{a'}{f'}$$

Now we found

$$\frac{1}{f - d} = \frac{1}{v} + \frac{1}{f'}$$

TABLE OF FOCI, &c.

No.	Type of Lens.	Actual Photographic Lenses.	Equivalent Focus for Parallel Rays.	Back Focus for Parallel Rays.	Optical Centre.	Rule for Conjugate Foci.	Notes.
1.	Single Positive Lens.	Landscape Lenses.	f	f	A fixed point, dependent on form of Lens.	$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$	Real, unless u less than f
2.	Single Negative Lens.	..	$-f$	None.	A fixed point, dependent on form of Lens.	$\frac{1}{f} = \frac{1}{u} - \frac{1}{v}$	Image virtual.
3.	Doublet Positive Lenses.	Rectilinear Lenses.	$\mathrm{F} = \frac{f_1 f_2}{f_1 + f_2 - a}$	$\mathrm{BF} = \frac{f_2 (f_1 - a)}{f_1 + f_2 - a}$	Not a fixed point, usually between Lenses.	No simple rule.	Lens positive, $a = 0$ till $a = f_1$
4.	Doublet Positive Lens and Negative Lens.	Steinheil's Antiplanat Dallmeyer's Tele-photographic	$\mathrm{F} = \frac{-f_2 f}{f_1 - f_2 - a}$	$\mathrm{BF} = \frac{-f_2 (f_1 - a)}{f_1 - f_2 - a}$	Not a fixed point, usually in front of Positive Lens	No simple rule.	Lens positive when $a > f_1 - f_2$ till

$$\therefore d = f - \frac{vf'}{v+f'}$$

$$= \frac{v(f-f')+ff'}{v+f'}$$

nce—

$$= v\left\{\frac{a+a'}{d} + \frac{a'}{f-d}\right\}$$

$$= \frac{v(v+f')(a+a')}{v(f-f')+ff'} + \frac{a'(v+f')}{f'}$$

$$= (v+f')\left\{\frac{f'v(a+a')+a'v(f-f)+a'ff'}{f'[v(f-f')+ff']}\right\}$$

$$= (v+f')\left\{\frac{avf'+a'f(v+f')}{f'[v(f-f')+ff']}\right\}$$

Vhen the extension is considerable approxi- tely—

$$= \frac{E}{f'}\;\frac{af'+a'f}{f-f'}$$

'inally, the angular diameter of the field of w is—

$$\tan^{-1}\left[\frac{a+a'}{d} - \frac{a}{f}\right]$$

$$= \tan^{-1}\left\{\frac{f(a+a')(v+f') - av(f-f') - aff}{f'[v(f-f')ff']}\right\}$$

$$= \tan^{-1}\frac{v(a'f+af')+a'ff'}{f[v(f-f')+ff']}$$

$$= \tan^{-1}\frac{a'f+af}{f(f-f')} \text{ approximately,}$$

l is therefore nearly constant.

have to express my regret that I have only w lantern slides illustrating the practical lication of the lens. They, however, illus- e the advantages of tele-photography in icting objects, magnified and clearly icted, situated at such distances from the tographer that ordinary photographic means hitherto rendered so small and insignificant to be useless. The two views of Mont nc serve as a warning against using the s in windy weather—one is woolly from nor, the other, perfectly sharp, was taken in m weather. The former was taken at a ance of 56 miles, and the latter at a dis- ce of 44 miles; the camera extension was inches, but an ordinary camera to attain same direct image would have required an ension of 25 feet!

'he series kindly lent me by Captain ipson, of the Intelligence Department of War-office, show the advantages of the s in hazy weather, and its power of analysing an ordinary view. The enlargements prove that ordinary negatives enlarged up to the dimensions given by tele-photography will not bear comparison. The applications to distant animals and architecture will recommend themselves. The latter may suggest the advisability to some of having a rather nearer approach than the conditions that obtained in the example shown, in that there is perhaps too much absence of perspective in the distant view, to please at any rate, although from the point of sight it appeared as you have seen it.

In conclusion, I can only add that I have endeavoured to trace, and place before you, all that has been hitherto accomplished in the direction of the attainment of enlarged primary images. The principle involved is contained in the rudiments of the science of optics; the application of the principle involved was first utilised by George Dolland, as set forth 60 years ago, in applying Barlow's lens to the astronomical telescope. I can only claim to have utilised the same principle in photographic lens construction, and hope the work done in this direction may be of service in the science of photography.

DISCUSSION.

Mr. W. E. Debenham said there could be no doubt that of the various lenses recently introduced this one produced the most striking effects, not only to the general public but to photographers. He had always been a great admirer of fine definition, of being able to see as much as possible, and a lens of this kind enabled one to see what otherwise could not be seen at all. He did not agree with some modern photographers, who were afraid of showing too much in a photograph. For astronomical work this method of giving a magnified image was obviously far superior to that of obtaining a secondary image, on account of the curvature of field in the first lens, and the curvature in the second so acting that they could only meet at one point near the centre. Flatness of field was of very great importance, as photographs were taken on flat plates. Occasionally curvature of field would be an advantage in taking objects of a particular form, but in the great majority of cases it was desirable to have as flat a field as possible. He had pointed out to Mr. Dallmeyer that the curvature of this lens being contrary to that of an ordinary lens, the use of a particular form as the positive element would produce an absolutely flat field, and this had been obtained. That was a very great point of utility, that you could get an absolutely flat field to a particular length of focus, and by the ingenious modification which had been shown that could be obtained at two distances, and, of course, anywhere near either of those, the field would be

approximately flat. The lens for the positive image should give very fine definition; and, as the negative element reversed the curvature, you could afford to neglect flattening, to some extent, in the positive, and so obtain a very high definition. He thought that was more useful than to have a lens which would give a great variety of amounts of magnification. He was sure this instrument would become very popular, as it would enable people to see what they could not see with the naked eye.

Mr. Clinton T. Dent said the application of this instrument in one particular direction—that of exploration—had a very great interest for him; and he was anxious to see how far it might be carried, especially in mountainous countries. In a journey, such as Mr. Conway had just come from, the value of a lens like this would be enormous, and might make all the difference between success and failure in an expedition. One of the views of Mont Blanc was familiar to him, but not the other, taken, he believed, from a point a few miles nearer; and he was quite convinced that, if such lenses could be used at all on mountain journeys, they would be of the greatest value. He should advise anyone exploring the Himalayas, for instance, to study the country he intended to traverse by such an instrument, developing the photographs on the spot, but there came in the question of portability, and the amount of exposure required, because it was necessary in work of that kind to take the views from a height, and generally in the open air, for you could not take them from the window of a room well sheltered. There was nothing so deceptive as a mountain at a distance, seen either with the naked eye, or by the aid of a telescope, but this method seemed to give great promise. Even at present it was very satisfactory, and he had no doubt it would be much further developed.

Mr. Julien Tripplin said it was impossible to speak too highly of the importance of this subject. During a recent journey to Scotland, a friend and himself came in sight of the old castle of the Gordons, and they were both very anxious to get a good view of the front, which bore inscriptions dating from the time of James I., but it was utterly impossible to obtain a view except from some miles distant, and at an inconvenient height; but with one of these beautiful lenses they obtained a very good photograph. He was also anxious to experiment on the moon, of which he obtained some good views a few years ago, but so small as to be almost incapable of dissection. Unfortunately, the weather had not yet been sufficiently favourable to enable him to get a good photograph with this new lens.

Mr. Page asked if this new negative lens could be used with an ordinary rapid rectilinear, such as he was in the habit of using, or did it require a special positive lens to be used in conjunction with it.

Mr. Debenham said there was one point he h[illegible] omitted to refer to before. One advantage of t[illegible] lens would be that it would accustom people to t[illegible] perspective of more than one kind. For instan[illegible] he must refer to the two views of St. Albans' Cat[illegible] dral, one taken with an ordinary wide angle l[illegible] from a short distance, showing what people had b[illegible] accustomed to see in such cases, which, though q[illegible] correct, some called it violent perspective; in [illegible] other the building was seen in unaccustomed p[illegible] spective; there was not the marked conveyance of [illegible] lines towards the points of sight which they w[illegible] used to. Both were equally true to nature, an[illegible] was well that people should learn to recognise th[illegible]

Mr. Oliver Williams said he should be g[illegible] to know if these lenses were obtainable by [illegible] general public.

Mr. Dallmeyer, in reply, said Mr. Debenh[illegible] had not brought forward any question which [illegible] could not entirely agree with. This question [illegible] perspective was one in which the lens might be [illegible] value. In the second view the point of si[illegible] was chosen which was most agreeable, with as m[illegible] magnification as was desirable. With regard to [illegible] sacrifice of definition in the positive lens, ultimat[illegible] bringing about better images in the final and co[illegible]plete optical system, he should say that his m[illegible] object was that to which Mr. Page had referred, t[illegible] there should be a possibility of utilising lenses alre[illegible] in use. Many people possessed portrait lenses wh[illegible] they would be glad to make use of, but he did [illegible] recommend the use of such a negative element w[illegible] a rapid rectilinear for two reasons—one, the impo[illegible]bility of correction through every plane, and [illegible] other, that the angle included would be so sm[illegible] that anything like magnification would be impr[illegible]ticable. Weak negatives could be placed on a l[illegible] focus lens, and so enable a short instrument to [illegible] constructed; but, if carried to that extent, the [illegible]dinary operator would prefer to use half a r[illegible] rectilinear, and get double the focus, to bothe[illegible] about the adaptation of a negative lens. He ha[illegible] thank Mr. Dent and Mr. Tripplin for their k[illegible] appreciation of his efforts. With reference to the vi[illegible] of Mont Blanc he could not say absolutely the [illegible]posure, but he believed it was about five or [illegible] minutes. The reason for that was that a small [illegible] was used, which was about $\frac{1}{2}$ inch, and a 25-[illegible] ortho-chromatic plate with a yellow screen; and [illegible] was near sunset, quite that exposure was required

The Chairman, in proposing a vote of tha[illegible] to Mr. Dallmeyer, said one of the reasons wh[illegible] lens of this description was needed, was owing to [illegible] imperfection of the photographic processes now [illegible] use. He did not say they were imperfect in e[illegible] respect, for in some points they were an impr[illegible]ment on the old wet plate processes; but he m[illegible] say that they were behind the first practical pho[illegible]

phic process introduced, viz., the daguerrotype delicacy. He recollected seeing a daguerro- e in which great care was taken in forming a y small image with a lens of 9 in. focal length, ch was capable of magnification to almost any ent. It was a case of a fortification, in which was desired to know the size of a certain part the walls which had been battered. A photo- ph was taken, three or four miles off, and, by a tem of microscopic examination, they were able olutely to trace the breach which had been made, l even to count the stones in the wall. Of course, ery good lens was used, focussed on that particular t of the field; but the daguerrotype plate was ch better for giving detail than those now in vogue. en with wet plate collodion Professor Piazzi Smyth s able, by a peculiar process, to take almost mb-nail photographs of parts of the Pyramids, which was able to magnify to almost any extent. The use of s lens was particularly to be commended, because present processes were rough and granular; and you enlarged the photograph you enlarged the in also, and thus produced a coarseness which you not have in a direct image. Of course, it might said that with a lantern you could enlarge the w and show every detail, and that was quite true; eat even Mr. Dallmeyer's lens, because you could arge a quarter plate up to 18 feet, and although 1 did not get absolute definition, still if you had d a good lens you got very fair definition, but you ld not always carry a lantern with you, and, refore, it was very useful to have a lens by which 1 could get a large image at once. It had been d that this lens was useless unless you had a per- tly still day, but he did not see that it was any re necessary to have perfect tranquillity in this e than when producing a plate for an ordinary tern slide. If you got a shake with a hand nera you would get exactly the same amount of ke with this, and the enlargement would come out ctically the same. This lens was going to be used observing the next eclipse, at the end of April, fact, two of them had been sent out along h another pair of lenses of $5\frac{1}{2}$ in. foci, by Mr. llmeyer, which had been used in several pre- us eclipses. The image of the moon, which uld be obtained with the one, would be about f an inch, and with the other nearly $2\frac{1}{2}$ in., that when the expedition returned they would able to see which gave the best result. His n idea was that they would both prove very ful. This one, of course, was considerably wer, he forgot whether it was five or fifteen times; t being placed side by side, they would be able to t five to fifteen exposures in the one as against the e in the other, and they could afterwards be com- red. The great desire was to get the details of at glorious light which was close to the sun's limb, e corona, and to find out to what it was really e, and they hoped by thus varying exposures, e shortest of which. however, would be only two seconds—to get greater detail, and thus be able to find out more than they had done hither- to. Mr. Dallmeyer had one slide which he had not shown, taken with one of these lenses; a photo- graph of the moon; he believed it was a 20 in. focus, and the image was of the same size as was obtained with a 10 ft. telescope. He was quite sure that it would be found very useful in astronomical work. At the Royal Observatory, images of the planets, Jupiter, and so on, had been taken, and the result had not been made known; probably, they would be shortly, at a meeting of the Royal Astronomical Society. Although the formulæ looked rather dry, he had been much interested in them, having worked a good deal on the optical properties of lenses; and he was glad to find that the calculations for these lenses were given in the paper, as they would be very useful. The lens in itself, though it looked like a small telescope, was not very heavy; and soon, he hoped, many people would be able to use and criticise them. Mr. Dallmeyer was always anxious to have his work criticised, and of the criticisms he always took advantage in further improvements.

The vote of thanks was passed unanimously, and the meeting adjourned.

Miscellaneous.

FRANCE AT THE CHICAGO EXHIBITION.

The February number of the *North American Review* contains an article by Sir Henry Trueman Wood on "The British Section," and one by Mr. Theodore Stanton, Commissioner Resident in Paris, on "The French Section." The following particulars are taken from Mr. Stanton's article:—

"The French display at Chicago may be divided into five sections, viz.: (1) the General Exhibit; (2) Fine Arts; (3) the Colonial Exhibit; (4) Women's Work; (5) Social Economy.

"The general exhibit, which covers the usual field embraced in International Fairs—agriculture, mines, machinery, manufactures, electricity, public instruction, &c.—will be large and brilliant.

"But *the* feature of the French exhibit will be the fine arts section. M. Roger-Ballu, the French Art Commissioner for Chicago, writes me: 'I am confident of the high value of our art exhibit. All of our artists, regardless of the distance which their works must traverse, have responded to our appeal with such eagerness that we have had to check their ardour. The administration, at the request of the jury, has had to limit each painter to three canvases. Our contemporary sculptors will be nobly represented, and the same thing may be said of the departments of engraving and architecture. The

casts for the exhibition, which are being made in our museums, will enable visitors to Chicago to obtain an admirable idea of the glorious past of our French sculpture.

"Our best representatives of decorative art have also insisted on the honour of being permitted to display specimens of our national taste in this department. Never before in the history of French art exhibitions has decorative art participated in the same exhibition on an equality with the products of plastic art and those of pure imagination. At Chicago France will proclaim for the first time in a World's Fair the principle that the words 'industrial art,' and 'decorative art,' are only prenomens, and that the word 'Art' is the family name.'

"Almost the whole of the eastern annexe of the Fine Arts Building will be given up to France. The large gallery near the main portion of the building will be hung with the works of French masters, loaned by the public and private collections in the United States. The French Art Section proper will consist of about 500 canvases, 150 engravings, 150 drawings, water colours, &c., perhaps 100 architectural designs, about the same number of pieces of culpture, and the large collection of plaster casts, referred to above by M. Roger-Ballu, and copies of many of the objects belonging to the great Paris State Museums, which represent every epoch of French art from the 11th to the 19th century. To these must be added the specimens of decorative art, and the valuable collections of porcelain sent by the celebrated State manufactories of Sèvres, Beauvais, and the Gobelins. 'Thus will be attained the aim of our art exhibit,' M. Antonin Proust writes me, 'to form a well-balanced *ensemble* of French art in all its manifestations.'

"The French Colonial Section will probably be one of the most popular at Chicago, and is sure to be exceedingly picturesque. The Algerian and Tunisian exhibits will be displayed in part in the Agricultural Building and in part on the lake near the Live Stock Buildings. Two original and very pretty structures will be erected there by M. Maurice Yvon, the French architect, and son of the well-known painter of that name. The first of these will be a Moresque pavilion, covering a surface of over 400 square yards. The second building to be erected by the Colonial Section is the Annamite Pavilion, which will cover an area of over 200 square yards.

"Around these two structures an Algerian garden will be laid, containing North African flora. The principal French colonies that will contribute to the exhibits displayed in these pavilions are, besides Algeria and Tunis, Martinique, Guadaloupe, Guyana, Congo, New Caledonia, Tahiti, and French India.

"The social economy exhibit at Chicago will be a *résumé* of the one which attracted so much attention from the thoughtful visitors to the Paris Exposition of 1889. 'The aim of the organisers of this exhibit,' M. Lami, the active secretary of the committee, writes me, 'is to show that, in the field of soci science, France means to retain the high rank whi she has always held.' The number of exhibitors quite large, notwithstanding the fact that many them are charitable societies of one kind or anothe with very small incomes.

"Besides these societies, several large Fren manufacturers have decided to make an exhib of the *ensemble* of the various institutions whic they have created for the purpose of ameliora ing the moral and material condition of their worl people.

"The women's exhibit will consist of beautiful lac and fans, ancient and modern; artificial flowe specimens of fine linen, several examples of dec rative art, Sèvres vases, embroidery, fancy wor some panels by Mme. Lervoudier, and specime of the art work of the chief feminine artists France, such as Mme. Léon Bertaux, the sculpto and Mesdames Jehanne Mazeline, Madeline Lemair Demont-Breton, Rougier, Louise Abbema, a other painters. Books written by women and doc ments concerning charities for, or directed by, wom will also be exhibited. 'We intend to show,' t secretary of the committee writes me, 'that t French women, in every condition of life, from t lowest station to the highest, is an active, intelligen hard-working member of society, who, when nece sary, is able to support herself, and who, wh blessed with fortune and leisure, displays an artist and literary intelligence of a high order.'

"A word remains to be said of two or three oth features of the French exhibit. The series of inte national concerts, organised for the summer of 18 by Mr. Theodore Thomas, will call to Chicago o or two of the leading French composers. Mr. Geor H. Wilson, Secretary of the Musical Departme of the Exposition, has already secured the promis presence of M. Camille Saint-Saëns, and it is hop that M. Massenet will also accept the invitati which has been extended to him.

"Several important French contributions will made to the United States Government exhib organised by Mr. William E. Curtis, of the Sta Department. Thus, Count Roselley de Lorgnes, t biographer of Columbus, sends a photograph of rare portrait of the discoverer, while the Du de Talleyrand lends the original of anoth famous Columbus portrait. A copy of the celebrat Behaim terrestrial globe is being made at the Pa National Library under the direction of Mr. Hen Vignaud.

"And last, but by no means least, is the co tribution to the department of fine arts made by t American artists residing in France. If I am n mistaken, these Franco-American pictures and scul tures are to be placed next to those of France in t Gallery of Fine Arts in Jackson-park, in order mark the close connection between master and pup and to show that this American school is only an o shoot of the great French school."

'RODUCTION OF BRONZE POWDER IN GERMANY.

The United States Commercial Agent at Fürth ıys that the greater part of the bronze powder exorted from Germany is manufactured in and near ıe cities of Fürth and Nuremburg, about a hundred stablishments being engaged, the factories being enerally situated on some small stream, where water ırnishes cheap power for driving the hammers and :amps. Bronze powder is composed of copper, tin, inc, and antimony melted in proper proportions, and ast first into rods of half an inch in diameter and bout three feet long. These rods are then rolled ntil about two inches wide, and then cut into suitble lengths for handling. These pieces then go to ıe hammers where they are beaten into a very small action of their former thickness, and are then taken) a sulphuric acid bath, where each sheet is washed) remove all impurities, rust and dirt. After being ıoroughly dried, the sheets are again hammered by eam hammers until no further reduction is possible, ıere being a limit to which machinery can be used. 'p to this stage the treatment the metal receives, hether intended for metal leaf or powder, is identical, ıt now the process changes. If designed for metal af the further beating must be done by hand, but if r bronze powder the sheets go to the shears, where ey are cut up into small particles, and now become ıown as clippings. These are now ready for the amp mills which are run in batteries, enabling one an to run or attend fifty or more. When sufficently pulverised, the powder is sifted in a peculiar anner, the heavier and better qualities going to one ceptacle and the inferior grades to another. The eaper qualities are mixed with quartz powder to able them to be sold cheaply. The expense of anufacturing bronze powder rests largely in the oduction of the clippings, a great deal of hand work ing required. Of late years manufacturers in the nited States have begun the manufacture of bronze ›wder, and have purchased the raw material in ıvaria, which appears to have excited fears that :imately the manufacture will be successfully inılled there and the business in Germany broken up. order to prevent such a disaster to themselves, e manufacturers of bronze powder have entered :o an arrangement whereby they all agree not to ll any clippings to be exported to the United ates except through a committee, which places the ders at an agreed price, namely, one shilling and reepence per pound, a price which they hope and pect will virtually stop the demand. Bronze powder sold at prices varying from one shilling per pound the very cheapest, to three shillings for the best ality, the duty being sixpence per pound irrespece of quality or value. The exports of bronze wder and metal leaf to the United States from the o places, Fürth and Nuremburg, in the year 1892, ounted in value to about £140,000, this country :ing the greater part of the German exports of ›nze powder.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

MARCH 8.—"Music in Elementary Schools." By W. G. MCNAUGHT.

MARCH 15.—"Technical Education: its Progress and Prospects." By Sir PHILIP MAGNUS.

MARCH 22.—"The Optical Correction of Photographic Perspective." By H. VAN DER WEYDE.

Papers for meetings after Easter:—

"Transatlantic Steamships." By PROF. FRANCIS ELGAR, LL.D.

"The Construction of Locks and Keys." By HARRY W. CHUBB.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m. :—

MARCH 9.—JERVOISE ATHELSTANE BAINES, I.C.S. (Bombay), "Caste and Occupation at the last Census of India." The LORD REAY, G.C.S.I., G.C.I.E., will preside.

This paper will be illustrated by lantern slides of various types of the Indian population.

APRIL 6.—Sir EDWARD N. COVENTRY BRADDON, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisation." The LORD BRASSEY, K.C.B, will preside.

APRIL 27.—Sir JULAND DANVERS, K.C.S.I., "Indian Manufactures." Sir ALEXANDER WILSON, formerly President of the Bengal Chamber of Commerce, will preside.

MAY 11.—Sir RAYMOND WEST, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results."

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock:—

MARCH 21.—CECIL FANE, "Newfoundland." Sir CHARLES TUPPER, Bart., G.C.M.G., will preside.

APRIL 18.—H. A. MCPHERSON, "The Philippine Islands."

MAY 2.—E. DELMAR MORGAN, "Russian Industrial Art."

MAY 18.—W. B. PERCIVAL, Agent-General for New Zealand, "New Zealand."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

APRIL 11.—PROF. PAUL SCHULZE, "History and Development of Pattern Designing in Textiles.' THOMAS WARDLE will preside.

MAY 9. — PROF. W. M. FLINDERS PETRIE, "Primitive Art in Egypt." EDWARD J. POYNTER, R.A., will preside.

MAY 30.—JAMES DALLAS, "Devonshire Pottery."

*** The meeting originally announced for March 14 will not be held, but will be replaced by an additional meeting in May.

CANTOR LECTURES.

Monday afternoons, at Five o'clock :—

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Three Lectures.

LECTURE I.—MARCH 6.—Analogy of Alloys to Solutions—Importance of studying the behaviour of Alloys while they liquify and as they "freeze"—Experimental Methods adopted in conducting the investigations.

LECTURE II. — MARCH 13. — Advances in our knowledge of Alloys, since the last course of Cantor Lectures "On Alloys" was delivered in 1888.

LECTURE III. — MARCH 20. — Applications of Alloys in Metal Work, with special reference to the Art Collections in the South Kensington Museum.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAR. 6 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Cantor Lectures.) Prof. W. Chandler Roberts-Austen, "Alloys."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. E. G. Mawbey, "The Leicester Main Drainage, &c., and the Construction and Testing of the Sewage Pumping Engines and Boilers."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. C. C. Hutchinson, "A Convenient Form of Experimental Apparatus for Filtrations, and other Determinations." 2. Mr. Watson Smith, "The Composition of the Petroleum-like Bitumen of Japanese Coal." 3. Discussion on Mr. Warrington's paper, "The Detection and Estimation of Lead in Citric and Tartaric Acids."

Surveyors, 12, Great George-street, S.W., 8 p.m., Mr. P. E. Pilditch, "Dilapidation Practice, particularly as Affected by some Recent Decisions."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Dr. Courtney, on "Kant."

TUESDAY, MARCH 7...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "The Functions of the Cerebellum and the Elementary Principles of Psycho-Physiology."

Civil Engineers, 25, Great George-st., S.W., 8 p.m. Mr. Walter Pitt, "Plant for Harbour and Sea-works."

Sanitary Institute, 74A, Margaret-street, W., 3 p.m. Dr. A. T. Schofield, "Home Sanitation in special reference to Cholera, Typhoid, and Diphthera." 8 p.m. Dr. Shirley F. Murphy, "Infectious Diseases and Methods of Disinfection."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

WEDNESDAY, MARCH 8...SOCIETY OF ARTS, John-stre Adelphi, W.C., 8 p.m. Mr. W. G. McNaugl "Music in Elementary Schools."

Geological, Burlington-house, W., 8 p.m.

Sanitary Institute, 74A, Margaret-street, W., 8 p. Mr. H. Percy Boulnois, "The Housing of t Working-classes."

Microscopical, 20, Hanover-square, W., 8 p.m.

Royal Literary Fund, 7, Adelphi - terrace, W.C 3 p.m. Annual Meeting.

Entomological, 11, Chandos-street, W., 7 p.m. Dr. D. Sharp, "Stridulating Ants." 2. M Charles J. Graham, "Notes on the Longicornia Australia and Tasmania (Part I.), including a L of the Species collected by Mr. J. J. Walk R.N., and Descriptions of New Forms."

Patent Agents, 19, Southampton-buildings, W.C 7¼ p.m. 1. Discussion on Mr. Hardinghan Paper, "The Adumbration of Inventions." Mr. A. M. Clark, "A Difference of Opinion: the True and First Inventor." 3. Mr. A. Woosna "Concurrent Patents for the same Inventior (postponed at the last meeting).

THURSDAY, MARCH 9...SOCIETY OF ARTS, John-stre Adelphi, W.C., 4½ p.m. (Indian Section.) M Jervoise Athelstane Baines, "Caste and Occup tion at the last Census of India."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Royal Institution, Albemarle-street, W., 8 p. Rev. Augustus Jessop, "The Great Revival: Study in Mediæval History."

Electrical Engineers, 25, Great George-street, S.W 8 p.m. Discussion on Mr. Mordey's paper, "No on Testing Alternators."

Camera Club, Charing-cross-road, W.C., 8 p. Colonel G. Gale, "Under the Broad Skies."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MARCH 10...United Service Institute, Whiteha yard, 3 p.m. Col. E. T. Hutton, "Marchi (mounted or on foot) as a Science."

Royal Institution, Albemarle-street, W., 6 p. Weekly Meeting, 9 p.m. Sir Herbert Maxw "Early Myth and Late Romance."

Civil Engineers, 25, Great George-street, S.W 7½ p.m. (Students' Meeting.) Mr. Charles Barker, "Methods adopted in Constructing Glasgow Central Railway Works—Bridgeton a Crongate Contracts."

Astronomical, Burlington-house, W., 3 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Sanitary Institute, 74A, Margaret-street, W., 3 p Dr. A. T. Schofield, "Neglected Facts of Hygie in Childhood and Home Life." 8 p.m Dr. J. Sykes, "General Powers and Duties of Iuspect of Nuisances."

Physical, Science Schools, South Kensington, S.W 5 p.m. 1. Dr. C. V. Barton, "The Applicatior Lagrange's Equations of Motion: with Espec Reference to a Perforated Solid in a Liquid." Prof. G. M. Minchin, "The Magnetic Field o Circular Current." 3. Mr. T. H. Blakesley, "T Differential Eqation of Electrical Flow."

SATURDAY, MARCH 11 ... Botanic, Inner Circle, Reger park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p Lord Rayleigh, "Sound Vibrations."

The Telegraphic Address of the Society of Ar and of the Royal Commission for the Chica Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.
No. 2,103. Vol. XLI.

FRIDAY, MARCH 10, 1893.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday afternoon, 6th March, Professor 'HANDLER ROBERTS-AUSTEN, C.B., F.R.S., elivered the first lecture of his course on Alloys."

The lectures will be printed in the *Journal* uring the summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the ward of the Albert Medal for 1893 early in ay next, and they, therefore, invite members the Society to forward to the Secretary, on or fore the 15th of April, the name of such men high distinction as they may think worthy this honour. The medal was struck to ward "distinguished merit for promoting ts, Manufactures, or Commerce," and has en awarded as follows in previous years :—

n 1864, to Sir Rowland Hill, K.C.B., F.R.S., or his great services to Arts, Manufactures, and mmerce, in the creation of the penny postage, and his other reforms in the postal system of this ntry, the benefits of which have, however, not n confined to this country, but have extended over civilised world."

n 1865, to his Imperial Majesty, Napoleon III., or distinguished merit in promoting, in many s, by his personal exertions, the international gress of Arts, Manufactures, and Commerce, the ofs of which are afforded by his judicious patron- of Art, his enlightened commercial policy, and ecially by the abolition of passports in favour of ish subjects."

1866, to Michael Faraday, D.C.L., F.R.S., r discoveries in electricity, magnetism, and nistry, which, in their relation to the industries e world, have so largely promoted Arts, Manu- ires, and Commerce."

1867, to Mr. (afterwards Sir) W. Fothergill ce and Professor (afterwards Sir) Charles Wheat- e, F.R.S., "in recognition of their joint labours tablishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measure and uniform standards by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the applications of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S., "because of

his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious labour."

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of the several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have hereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (now Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (now Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

In 1887, to Her Majesty the Queen, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value o[f] his researches in various branches of science and o[f] their practical results upon music, painting, and th[e] useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for hi[s] achievements in promoting the Arts, Manufactures and Commerce, through the world-wide influenc[e] which his researches and writings have had upon th[e] progress of the science and practice of metallurgy."

In 1890, to William Henry Perkin, F.R.S., "for hi[s] discovery of the method of obtaining colouring matte[r] from coal tar, a discovery which led to the establish[-]ment of a new and important industry, and to th[e] utilisation of large quantities of a previously worthle[ss] material."

In 1891, to Sir Frederick Abel, K.C.B., D.C.L. D.Sc., F.R.S., "in recognition of the manner i[n] which he has promoted several important classes [of] the Arts and Manufactures, by the application [of] Chemical Science, and especially by his research[es] in the manufacture of iron and of steel; and al[so] in acknowledgment of the great services he ha[s] rendered to the State in the provision of improv[ed] war material, and as Chemist to the War Depar[t]ment."

In 1892, to Thomas Alva Edison, "in recogniti[on] of the merits of his numerous and valuable inventio[ns] especially his improvements in telegraphy, in tel[e]phony, and in electric lighting, and for his discove[ry] of a means of reproducing vocal sounds by the phon[o]graph."

Chicago Exhibition, 1893.

REGULATIONS GOVERNIN[G] AWARDS.

The following circular, which supersedes t[he] one printed in the *Journal*, February 17th (s[ee] *ante* p. 323), has been received by the Roy[al] Commission :—

Rule 1. Conformably to the determination of [the] Commission, "awards shall be granted upon spec[ific] points of excellence or advancement formulated [in] words by a board of judges or examiners, who s[hall] be competent experts."

Rule 2. *Board of Judges.*—This board of jud[ges], which shall be composed, as far as practicable [of] competent experts, shall be divided into thirt[een] committees, one of which shall be assigned to e[ach] of the thirteen great departments of the Exposit[ion], as recognised by the classification adopted by [the] World's Columbian Commission. The numbe[r of] judges composing this board, and each commi[ttee] thereof, shall hereafter be determined. There s[hall] be one or more women judges upon all committ[ees] authorised to award prizes for exhibits which ma[y be] produced in whole or in part by female labour; [and]

he number of women upon such committee shall be iereafter determined according to the method hereofore prescribed by said Commission, after conference with the President of the Board of Lady Managers and the Awards Committee thereof.

Rule 3. *Individual Judges.*—The individual memiers of the said thirteen committees shall be, so far s possible, competent experts, and shall perform uch duties and examine such exhibits as shall be ssigned them by the Executive Committee on Awards. There shall be a foreign representation pon each one of these thirteen committees, and the umber of foreign judges will be fixed when the haracter and extent of the participation of the arious foreign nations shall have been ascertained.

Rule 4. Each committee shall, at the call of the Executive Committee on Awards, organise, by the lection of a president, vice-president, and secretary, nd shall keep a record of all returns and reports by ie individual judges, as hereinafter provided for.

Rule 5. *Duties of Judges.*—It shall be the duty f each individual judge to make a report in writing, ver his signature, of the result of the examination of ich exhibit primarily examined by him, as each exnination shall have been completed; and as to very exhibit so examined which he shall deem orthy of an award, he shall formulate in words the iecific points of excellence or advancement disclosed ereby, and which, in his opinion, render it worthy an award. Every report shall be submitted, as on as possible, to the committee of which such dge is a member, for a finding in the premises; and every case where, by the vote of the majority of ch committee, it is determined that an exhibit is orthy of receiving an award, said committee shall rthwith formulate, in written words, the specific ints of excellence or advancement which, in his inion, warrant the award, and transmit the same, rtified by its President, or Vice-President, and cretary, to the Executive Committee on Awards. id in case the finding of the committee shall differ im the conclusion of the individual judge making preliminary examination, either as to its being rthy of an award or as to the character of the ints of excellence or advancement it possesses, it ill be so distinctly stated in the report of said nmittee. In every case where the finding of the partmental committee coincides with the conclun of the individual judge, the said committee shall nsmit, with such finding, the report of such indiual judge to the Executive Committee on Awards; l in those cases where the finding of the departntal committee does not coincide with the consion of the individual judge, then the finding in h case shall be accompanied by the written report one of its members who shall have examined the ibit, formulating therein in words the specific nts of excellence or advancement possessed by h exhibit.

Rule 6.—In every case, where the finding of the imittee is not in accord with the conclusion of the individual judge, it shall be within the power of the Executive Committee on Awards, if, in its judgment, justice demands it, to refer the report back to the committee of that department whence it emanated, with the direction to review, and further consider the case, and report its finding under such review without delay, to said Executive Committee on Awards; and such finding shall be conclusive.

Rule 7. *Notice to Foreign Nations.*—This Executive Committee on Awards shall communicate, through the Director-General of the World's Columbian Exposition, with the foreign governments which have appointed commissions to represent them at the World's Columbian Exposition, or with the said commissions directly, stating the character of the awards, the ground upon which they are to be granted, and the requirement that all judges shall be, so far as practicable, competent experts. And the foreign governments shall be invited to recommend, previous to March 1, 1893 [time extended to March 15], experts in the various departments, and from those named the Executive Committee on Awards may make selections. The especial attention of foreign governments shall be called to the fact that there will be one class or kind of medals, which will be made of bronze and be works of art, and be accompanied by parchment diplomas, on which shall be formulated the specific points of excellence presented by the exhibit receiving the award. Notice shall be given to all exhibitors, whether domestic or foreign, that the medals and diplomas to be awarded are by authority of the Congress of the United States, and are prepared by the Secretary of the United States Treasury.

Rule 8.—Should any exhibitor, domestic or foreign, become a judge under these rules, his or her exhibit shall be excluded from examination for award, but the Executive Committee on Awards may cause such exhibit to be examined, and a report thereon made, to complete the history of the Exposition.

Rule 9. *Right to Examine Exhibits.*—Any exhibitor may have his exhibit exempt from examination for award by notifying the Executive Committee on Awards; otherwise, the Executive Committee on Awards shall have the right, through its regularly appointed judges, to examine every exhibit, domestic or foreign, whether presented by an individual, association of individuals, institution, Government, or department therefore.

Rule 10. *Date of Commencing Work.*—The work of the judges shall commence not later than the 1st day of June, 1893, and shall progress uninterruptedly until the completion of the work assigned them, except in the Department of Live Stock, and in those departments where the nature of the exhibits requires renewal from time to time during the Exposition.

Rule 11.—Upon the completion of the work of the judges, the results thereof shall be presented by the Executive Committee to the full Committee on Awards, which committee shall in turn report to the

World's Columbian Commission, or, in its absence, to the Board of Reference and Control, by whom the formal promulgation of the awards and the distribution of medals and diplomas shall be made with appropriate ceremonies.

Rule 12.—In addition to the reports by the individual judges of the various exhibits, each of the thirteen committees shall present a comprehensive report, signed by the President and Secretary, embodying the principal educational and interesting features of the groups and classes composing that departments, accompanied by a list of voters who have received awards, with the reports of the individual judges, giving the reasons and considerations thereof; and this report shall be delivered to the Director-General, to be included in, and to form part of, the history of the Exposition; but this shall not be so construed as to prevent or interfere with the duty expected of each of the department chiefs to prepare and submit, as part of the official history of the Exposition, a complete and comprehensive report of the work of his department.

Rule 13.—In the performance of the duties intrusted to the Executive Committee on Awards, any member thereof shall have the right to be present at the deliberations of the committees herein provided for, and in all matters of review or other complication the said Executive Committee shall have the right to avail itself of the aid and service of any member or members of the Committee on Awards, and as well of the advice and assistance of any competent agency whose aid ought, in its best judgment, to be invoked.

GEORGE R. DAVIS,
Director General.

Administration Building, Exposition Grounds,
Chicago, January 16, 1893.

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tuesday, February 28, 1893; C. M. KENNEDY, C.B., in the chair.

The CHAIRMAN expressed regret that Sir Philip Cunliffe-Owen, who was to have presided, was prevented from being present owing to severe indisposition.

The paper read was—

RUSSIA AS A FIELD FOR TOURISTS.

By SIR EDWARD BRADDON, K.C.M.G.

It was my good fortune to be called upon, as the delegate of Tasmania, to attend the International Railway Congress that met at St. Petersburg on the 20th September, 1892. I say it was my good fortune to be officially summoned because, had not duty compelled, I should probably never have seen Russia, or come to learn how entirely mistaken were many of my views as to the social and political life, manners and customs of this very interesting country.

I do not suppose that I started for St. Petersburg with more than the average ignorance of and prejudice regarding, Russia and her ways obtaining amongst Englishmen, unless, indeed my Indian experiences had imbued me with a larger measure of mistrust of Russian diplomacy than that which ordinarily prevails. I believed that in my reading of Russian history social and political, I had exercised a staid discrimination that fully compensated for exaggeration and distortion on the part of biassed writers. But I am free to confess now that, in spite of what I considered a calmly judicial and philosophical attitude in this respect, I was egregiously mistaken in many of my opinions.

There is an aphorism (I think of Dr. Johnson's) to the effect that a travelled fool is none the wiser for his wanderings, but this, however disparaging to one class of travellers, does not affect the general conclusion, that it is only by personal experience of a country that one can thoroughly realise its physical and many other characteristics, and as a set off against the above aphorism, I may quote Cowper's lines—

> "How much a dunce that has been sent to roam
> Excels a dunce that has been kept at home."

No word painting can be other than an indifferent substitute for direct observation. The best descriptive writing can only give to the most careful student a skeleton idea of a strange land; and this may easily be filled in with incorrect details and must necessarily be wanting in the essential features of light and shade.

But every reader is not a careful student. Very many readers are the reverse of eclectic and prone to leave the better portion of their reading undigested, while they assimilate that of inferior quality. Of not a few it may be said that they assimilate nothing, except, perhaps catch phrases, proverbs and the like, that have come haphazard into their brain, what time that brain was very much an empty storehouse and stopped there. I went to Russia equipped with some of this mental lumber, notably with the legends that the Russ was animated by a passion for train-oil as a beverage, and that every Russian had a subcutaneous stratum of Tartar.

And let me say after this exordium, that I

ot pretend to teach what others more capable ave sought in vain to do. I do not go the :ngth of saying that I can present an account f Russia that shall be of any educational alue. My aim is solely to lead others, if they e tempted by my experience, to go and study :ussia for themselves; my reward will be the rateful thanks of those who find that country s interesting and enjoyable as I did. One ord more, I am not about to inflict upon you diary or guide-book.

If I entered Russia grossly ignorant of that ountry and all its works and ways, it was not ›r want of inclination—even if somewhat ostponed—to learn, for up to the moment hen I reached the frontier I was engaged in tudy of this subject. Somebody had recom-ıended for this purpose "My Official Wife," novel by an American who had, they told ıe, been in Russia. This work affects to escribe Russia, and I read it for that reason. But even on the frontier this book misled ıe, even to the extent of putting that frontier ı the wrong place. Eydtkuhnen is the German ontier station, not that of Russia. It is not t Eydtkuhnen that there is any change of auge, or 2½ hours' delay for inspection of bag-age and passports, as this novel tells me. ›ne passes Eydtkuhnen after a brief halt, and rrives in the course of about five minutes at Vierbalen, which *is* the Russian frontier :ation.

Having placed the frontier in the wrong lace, this authority went on to people it in a ıanner highly creditable to his imaginative ıculty. "Here," he says, "painted posts in ıe national colours, double-sided, impress lence, discretion, and political prudence ı the passing traveller. This warning is eightened by the presence of armed soldiers ıcing on parallel lines a few yards apart. In ıe differing uniforms of the august majesties Germany and Russia, fierce warriors glare : each other jealously on their sentry beats, ıd face about with a catchy snap and wooden rk suggestive of toy soldiers."

There is a delightful touch of irony about ıe political suggestiveness of double-faced ›sts that would go a long way to redeem the ost incorrect description. There is in the hole passage above quoted the forcible pre-ntment of two nations in arms barely re-rained from coming to a death grip upon at border. One almost hears the clang of ms and thunder of the approaching war orm as one reads it. But the picture, as :re drawn, is one that I could in no way realise, going or coming, either at Eydtkuhnen or Wierbalen; the only armed persons I saw being a revolver-equipped policeman at the former station, and two or three sabre-wearing soldiers at the latter. In short, all the terrors of the passage across the border, including a formidable iron *grille*, described in "My Official Wife," were conspicuous by their absence.

Of course I was armed with the indispens-able passport that covered my party of three—my wife, my secretary, and myself; and, equally of course, one would prefer that greater freedom of travel which, in the more western countries of Europe, permits the going to and fro without this official sanction. But, after all, the cost of a passport is inconsider-able, and the trouble connected with the viséing, &c., in Russia, is taken off one's shoulders by the hotel-keepers, who take charge of it, as its, and its owners', natural guardians.

The history of our passport may be told in a few sentences. At a cost of 3s. 8d., a clerk obtained from the Foreign Office (London), the official declaration that it, in the name of the Queen, required "all whom it might concern to allow us to pass freely, without let or hindrance, &c.," and the necessary *visée* by the Russian consul-general. This document was duly presented to the authorities at Wierbalen, glanced at, and returned: it was taken over, held, and *viséed* for us by the proprietary of our St. Petersburg hotel at a cost of 25 kopeks (6d.). It was similarly treated, but in a more expensive manner, by the Moscow hotel people, who charged us two roubles (4s.) for their ministerings. It was handed to us on our departure from Moscow much bestamped, and inscribed with permission to leave the country; shown to the Wierbalen authorities again, for perfunctory examination; and then finally put away as one of many souvenirs of a very pleasant trip.

In this connection I may state that, as to the character of Russian police administration generally, I came to be greatly disillusioned. Herein lay one of the fallacies that I had treasured up as valuable scraps of knowledge. I had believed that restriction of the liberty of the subject and espionage were ever present and disagreeably obvious, and I found it otherwise—a life-long theory was utterly shattered by three weeks' experience.

Espionage exists, no doubt, and is of a closer domiciliary character than is to be found elsewhere. The hall-porter of your

hotel is a police-agent, who reports your incoming and outgoing, your visitors, your letters received and despatched, when you have rendered yourself sufficiently interesting to require this constabulary attention, or he is sufficiently alert to bestow it. The dvorniks whom, if a householder, you have to employ to sweep and water the roadway and pavement along your frontage—who also, by shifts, act as watchmen through the night, sitting upon stools at the house doors—are likewise police emissaries, but not always very vigilant in their night-watching, for I frequently passed one nodding or fast asleep upon his post. How these poor wretches can be supposed to keep an eye upon anything but chance frost-bites during their midwinter sentry-go, I am at a loss to imagine.

But this espionage at one's very gate does not obtrude itself upon one's notice; and the ordinary visitor, after our fashion, need know nothing of it, and certainly is subjected to no annoyance by it. As for the perceptible police—they who parade the streets in uniform—these were very few and far between, and, apparently, very little concerned with the minor indiscretions of the people, even when conspicuously brought under their notice. Thus, on two several occasions, I saw the spectacle of a drunken and somewhat disorderly *moujik* being led away by a less intoxicated companion, and this with as little notice as if the Russian law gave its countenance to license as well as liberty. These uproarious *moujiks* gave me the idea that they believed themselves to be in a free country. In democratic London they would possibly have been hauled before a magistrate, and heard from his Rhadamanthine lips some such formula as "20s. or a fortnight hard."

Not that the *moujiks* or any other person one meets in the streets of St. Petersburg or Moscow are commonly disorderly; on the contrary, they appear to be, as a rule, quiet and well conducted, but, withal, conscious of possessing reasonable freedom. Other evidence than that of the street came under my observation, and of this I give the following instances.

We of the Congress were taken on an expedition into Finland, what time the new line to Imatra was opened. We were nobly entertained by the Finlanders at Imatra, and an assemblage of very mixed nationalities sat down to a banquet given in honour of the occasion. Russians were there in plenty; officers of the army, officers of the railway department, possibly officers of the police, b[ut] the presence of these many Russians did n[ot] prevent the Finlanders from expressing, mo[re] or less openly, their distaste for Russian rul[e] and I have reason to know that, so far, one [of] the most outspoken of these Finlanders ha[s] not been interned in a fortress or despatche[d] to Siberia for his hostile criticism. But th[at] was a day of hilarity, and a measure of freedo[m] that almost expanded into licence—a day tha[t] in a way, celebrated the great brotherhood [of] man—a day upon which a Moslem Pasha nearl[y] rendered himself an unspeakable Turk b[y] hobnobbing with a Russian general, and on[e] of the Chinese delegates embraced the wife [of] a Belgian, *coram publico*, before the assembled Congress.

Another instance of this freedom was th[e] openly expressed opinion of an officer of th[e] Russian Guards, that the Emperor was unpopular with the army, because less mindful [of] its well-being than his predecessors had bee[n]. These views were expressed openly in a publi[c] place, before a mixed company; no on[e] present appeared to be struck by the critic['s] daring; and, as far as I know, that office[r] suffered no pains or penalties for his remark[s]. It was, however, subsequently explained to m[e] by a railway official of rank and distinctio[n] among engineers, that there was another sid[e] to this question, in that the present Emper[or] has, in the interests of the army at larg[e], deprived the Guards of some of their cherishe[d] privileges — an instance of that process [of] levelling-down which has been going on i[n] Russia for some time.

Only on one occasion did I observe an[y] hesitation on the part of a Russian to discus[s] political questions. A Russian lady asked m[e] why the English did not give Home Rule t[o] Ireland. As time and the occasion did n[ot] permit of my giving the hundred-and-on[e] reasons against this, even if I had been prepared with them, I brutally resorted to th[e] *tu quoque* by asking why Russia did not giv[e] Home Rule to Poland, and that silenced her.

Among the surprises that awaited me i[n] Russia was the freedom with which such awkward subjects as Siberian exile are depicted i[n] paintings that are openly displayed in publi[c] galleries. Russia possesses no public opinion as expressed by the Press: the most harmles[s] criticisms of Russian politics published b[y] journals of other countries are blocked ou[t] (*caviared* they style it) of any paper brough[t] into Russia; for, except those that come to th[e] embassies, all such newspapers, on arrival b[y]

post, are delivered to the police for scrutiny and manipulation. But, in spite of this absence of journalistic criticism, on the walls of Russian art galleries may be seen grim satires upon the national faults and follies, the horrors of war and Siberian exile being shown with terrible distinctness.

What espionage cannot do for the protection of the Emperor and others from the enemies of the State and order, seems to be attempted by elaborate precaution. While we were there, the movements of the Emperor (those movements which concerned the Congressional delegates) were not known to us or the public any time beforehand. We were banqueted at the Winter Palace, but up to the last moment it was left undecided whether the Emperor was to be present or not, and eventually we sat down without him. We were invited to witness a parade of the *chasseurs* of the guard before the Emperor; we were told that this would occur at a certain time and place, and, at the last moment, only learned that both time and place were other than those originally fixed.

As far as my limited observation goes, it leads me to the conclusion that of all Russians, the Emperor is the least truly free. A man of simple tastes, who infinitely prefers to be engaged in woodcraft amidst the trees of Gatschina rather than in the pomp of sovereignty, he is, they say, happiest when, with his family, he strolls about Copenhagen, enjoying himself as a simple citizen. His reception of several of the congress delegates at Peterhoff was an admirable example of this simplicity. Court dresses and pageant were not on this occasion. The Emperor and Empress received the delegates without display of any sort, except that of kindly notice and entertainment. They spoke to all a few words, lunched them sumptuously, and sent them away thoroughly satisfied in every sense.

That levelling down of the people to which I have referred has, accompanied by much levelling up, been going on for half a century. Lady Bloomfield, in "Reminiscences of Court and Diplomatic Life," speaks of the improved position attained by the serfs, some of whom were the actual owners of their (nominal) master's estates. Already the abolition of the law of primogeniture, introduced by Peter the Great, and abolished seventy years ago, was causing the disruption of large estates, and the transfer of property from the aristocrats to wealthy traders. Greville, in his Memoirs, speaks of this as having commenced in 1829; and the emancipation of the serfs quickened this disintegrating movement. In "Round the Kremlin, Pictures of Life in Moscow," published in 1868, it is mentioned that the fashionable quarter of the city had passed out of the hands of the old nobility into the possession of rich merchants, and the author noted with amazement that two people of the tradesman class ventured into the exclusive Hotel Dussaux, and were permitted to remain there. He also noticed that Russian, formerly held in contempt as the language of serfs, had come to be the common tongue of the classes. This last point is still more noticeable to-day. Russian is the language of all the Russians, high and low. The national spirit that was awakening in 1868, is now fully developed; Russia now regards herself as wholly independent of other nations, except in the matter of foreign loans, and sufficient unto herself in all respects. The national spirit is expanding in the direction of exclusiveness, and yet among the wealthier classes it is still the custom to teach children English and French; and, I think, a uniform practice to lavish hospitality and attention upon the stranger in the land.

I should say that kindness is a marked characteristic of the Russians as a people, Siberia and the knout notwithstanding. Their large-hearted charity is evidenced by their many institutions established and maintained for the relief of stricken humanity, prominent among which is the celebrated Foundling Asylum at Moscow. Their kindness is manifest in their admirable courtesy to man, and tenderness to animals. The horses seen in St. Petersburg and Moscow, even in droschkys that may be hired at fares as low as 2d., are in good condition, and evidently carefully handled, although a man and pair of horses may be hired at two roubles a day. The cats that sit outside houses and shops, like an inferior class of *dvorniks*, are not in the same category as the feline fugitives that in London dart from area to area, like creatures under the burden of guilt and fear; they are sleek, purring, and confident, ready to make friends with the passer-by, and on the best of terms with themselves. So with the dogs of the streets, that here are not waifs destined to the lethal chamber of the Dogs' Home. So with the pigeons that, crowding upon the roofs and cornices of the Grand Morskoia arch, fluttered down in battalions upon the ledge outside our casement, and then, plucking up courage, sauntered into our room to share our breakfast.

And for the courteousness of the people, is it not told by Lady Bloomfield, how the Cesarevitch at a court function waited upon the Emperor's guests? We, too, can bear testimony of a like kind, notably in the case of the Mayor of Moscow (merchant, millionaire, and the confidential friend whom the Emperor recently sent into the distressed provinces, to inquire into a report upon the extent of the famine, if famine existed) for this host, at the splendid banquet given in honour of the Railway Congress, waited upon the guests all through the meal, with the zeal of a footman and the *aplomb* of a courtier.

As for Russian hospitality, I can only describe it as reckless; and, in forming this opinion, I am not so much influenced by the succession of lunches, fêtes, and dinners, with which the Emperor, the railway administrations, ministers and public bodies, entertained the 200 or 250 delegates and their suites, as by the spontaneous bounty of private Amphitryons. Few as were our opportunities of partaking of this outside hospitality, we had enough of it to show how full-handed it is, and how any chance of offering it is seized upon by the Russians.

One evening (when, happily, we were free from the obligation of congressional and gregarious feeding) was made especially pleasant to us by a chance remark of my wife's that she was fond of horses. The Russian gentleman to whom this was made seized upon it at once, and invited us, for the next afternoon, to drive with him in a troïka to the Islands and dine with him there at one of the riverside restaurants. The next afternoon brought the troïka (the favourite one of a sporting Grand Duke) with a team of three fine-conditioned and gaily caparisoned horses that had been prizewinners in many a show; and away we drove, at the rate of twelve miles an hour or more, over the Neva and on through the Islands to our restaurant. There we had a *récherché* dinner in a private room overlooking the river, and there our host, while we discussed *caviare*, and fish soup, and sterlet, and baby capercailzie, and hock and champagne, and coffee and cigarettes, discoursed upon many things, but more particularly about railways, with a fluency of English and grasp of his subject that would be creditable to a British M.P. or M.I.C.E. I was more especially struck by his knowledge of Australian railway matters, of which it would be vain to expect the British M.P. to know anything whatever. He had at his fingers ends the whole history of the difficulties that had arisen in Victoria and New South Wales between the Railway Commissioners and the politicians, and it was obvious that his respect for the latter was of an attenuated order, although he very thoroughly appreciated the political, as distinguished from the commercial, value of railways, and held views upon this point that would be as welcome to Australian statesmen as they would be unintelligible to many of the British financiers who find the capital for colonial public works.

And, after this feast of reason and other good things, home (*i.e.*, to our hotel) through the shades of many avenues and falling night; the two outside horses at a good round gallop while the centre horse kept up a steady trot, the Izvostchik shouting encouragement to the springing steeds and our host now and agair shouting in kindred excitement, and now and again explaining to us how this is nothing to the wild delight of winter-sleighing, when noiselessly the troïkas glide over ice and snow, and the only sounds that reach the ear are the shouts of drivers and their excited freight From my experience of that evening I can quit realise that these sounds would be audible.

I had been accustomed to regard the Russian as stolidly imperturbable in all matters, as the are in gambling and the sullen pertinacity c battle; I came to think them otherwise. should say, now, that they are strangely ex citable—prone to outbursts of an excitemer which is not altogether mirthful or joyous, bu rather like the hilarity induced by wine, an liable to sudden reaction that precipitates the into the depths of depression. More than ar other man does the Russian realise the forc of that line of Byron's, "Oh, man, thou pend lum betwixt a smile and a tear." Even o world-travelled and widely-read friend of t troïka was distinguished in a marked degr by this changing temperament.

This was very noticeable also in the *prin donna* of a singing and dancing troupe Tziganes, or gipsies, or Little Russians (no o could authoritatively determine the national of these people except as to two Tart members of the band) that performed at t French Ambassador's and the Arcadia Garde for our edification. That *prima donna* had perfectly beautiful face, and when she exe cised her powers of fascination, her eyes a lips smiled with a quite bewitching *espiègler* But in moments of repose the brightness pass out of her face and left upon that lovely ma an expression of deepest gloom. If she was native of Little Russia, it is possible that sa

est thoughts of her home—that fair land of 'oland, of which one hears in the "Bohemian ;irl"—banished joy from her heart and face. Speaking generally, the Russian woman, ith emotions more restrained than man's, eems, like him, to have her marked contra-ictions of temperament; but, like her illogical ex, she displays the two contradictory phases t one and the same time. The Russian young ıdy is bold without immodesty, and shy without *aucherie*, and she is both at once. Danger-usly fascinating was one of these who, seeing s at a *fête* as strangers ignorant of Russian, traightway introduced herself as *chaperone* nd interpreter, guide and friend, but hardly hilosopher. Even when she demonstrated y example that *caviare* (eaten with a spoon, ke strawberry ice) and *vodka* were the correct ıings to take before lunch, we remained under ıe spell of her soft English-speaking voice and ıe veiled lightnings of her eyes. Possibly, ıe independence of Russian ladies in the ıatter of *chaperonage* has something to do 'ith this. Our particularly fascinating ac-uaintance, and others whom we encountered, ttended various entertainments without escort f any male relative or matron quite as a ıatter of course, trusting to chance for a avalier to see them to their carriage. I bserved that our captivating young friend ex-erienced no difficulty in obtaining her cavalier.

This note of sadness underlies or permeates Russian music, and is only displaced, if, in-eed, it be displaced, from the splendid ational anthem by a grand solemnity. It is ot more tuneful than that of Wagner—clash nd clangour, rather than air, being apparently ıe object of Russian bands and orchestras. he minor key is largely used, and the singing t the Grand Opera of Moscow (specially rranged for the Congress) seemed to us uni-ırmly a semi-tone below the accompaniment. ut some of the church singing without accom-animent is magnificent, and the tenor of the ittle Russian troupe sang delightfully, but ithout orchestral aid, save the occasional nkling of two guitars.

The absence of the organ from the churches rikes the English visitor, who has not been ı a Greek church in any other country, as ımething strange, but very effective is this ıusical service of fine human voices and ɜpecially rich basses. Grandly do the notes se and fall and resound through the dim and igh-roofed aisles of St. Isaac and Notre 'ame de Kasan and other fanes, the most ɔlendid of which has no seats, no accommodation whatever for the worshipper but the pavement, upon which the devout may kneel or stand as it pleases him.

Piety, as far as external showing goes, is a striking feature of the Russian people. Busy men, of all classes, cross themselves and uncover as they pass a shrine or cross or pictured saint, such as that over the Nicholsky gate of the Kremlin; and in the churches the more pious of the congregation prostrate themselves and lay their foreheads on the pavement innumerable times—and this with a total disregard for appearances and the possible criticism of scoffers. Even the rank and file of the *chasseurs* of the guard, when paraded for a solemn service, showed this devoutness. One sees the same open performance of religious ceremonial among Mahomedans and Hindoos. The Moslem will spread out his prayer-carpet and kneel towards Mecca, although alone in a crowd of Kaffirs. The Hindoo will count his beads and mutter his *muntros*, albeit an army of people of other creeds be looking on. But one cannot conceive the idea of either a British count or cobbler doing open reverence to the cross on St. Paul's. In external respect, the Russians bow before things less solemn than the emblem of his faith: he bends the knee to saints' and Virgin statues and pictures on walls and in niches of arches; and I am inclined to think that the picture of the Emperor is almost included by the perfervidly devout Russian in the category of saints. At any rate, no well-mannered and loyal Russian will turn his back on the Emperor's portrait in the Moscow Mayoralty, for when we banqueted there, the side of the head table that fronted the Emperor's portrait was unoccupied for some distance on either hand of that counterfeit presentment.

As corroborative of the view that this national piety is genuine, I may mention how the children save up their kopeks to buy from the priests sacred oil to keep lamps burning on the shrines of the Virgin, St. Serge, and St. Nicholas; and adult pilgrims struggle for the possession of the holy water drawn from the Troitsa well, being at pains to get this, much after the manner of the Hindoo in respect to the water of the Ganges and other sacred streams, that he carries home at considerable trouble, and over many weary miles of travel.

Greatly as Russia has become Westernised upon many points, she still retains many features besides that of the Troitsa holy water

that are essentially Eastern. Moscow, with its hundreds of cupolas, bell-towers, and minarets, might well pass for Damascus of old or Lucknow of to-day. The battlemented walls of the Kremlin (more like the creations of the stage-carpenter than defensive works) help, rather than destroy the illusion. And looking down upon this most picturesque city from the Sparrow Hills, some six miles out, one is lost in admiration of the spectacle spread out at one's feet, and hardly able to realise that it is other than Asiatic. It was from a point on the Sparrow Hills (where there is now a restaurant, whose uses and position are very much those of the Richmond "Star and Garter") that Napoleon took his first view and draught of the intoxicating beauties of Moscow, and one can well conceive how he felt in regard to it such emotions as those which stirred the heart of the Saracen conqueror of Damascus when he descended upon that city.

One sees this Eastern tinge in the architecture even of the greatly modernised St. Petersburg. The gilded domes of St. Isaac's Cathedral and other churches, the towers and cupolas that line the river-bank and are shadowed in the wide waters of the Neva: and many another building are of an Eastern type, albeit that the old Russian type of house has here, as in Moscow, been superseded by that of Western Europe: and the Nevski Prospect almost transformed into a Parisian *boulevard*.

One sees it, too, in that system of bribery which is said to taint Russian justice at its fount, and through its sources; and in the practice of hoarding coin, that practice which some twenty-five years ago prevented a gold sterling currency from being established in India, and which is here one of the causes (the drain of money during the Crimean war being the main one, and the adverse balance of Russia's external trade another potent factor in this direction) of the very limited coin circulation now existing. I did not see a silver rouble or a Russian gold coin of any sort during my three weeks in the country: all the money I handled consisted of one, three, five, and ten rouble notes, and some nickel fractions of a rouble of values from five to twenty kopeks. But it is easier to get accustomed to paper money, even when that paper is not always as clean as might be desired, than to accustom oneself to having no money at all: and I cannot say that the frequent handling of Russian notes and nickel detracted from my enjoyment of things in general.

Again, this Asiatic colouring is to be seen in the partial relegation of women to a lower sphere than that occupied by man. A woman may not enter within the altar rails or other more sacred portions of a Russian church where man, even a layman, is free to go. Her presence there is desecration, that involves re-consecration of the edifice.

But many of these Eastern features of the country only add to the novelty of Russia and in some degree, to its attractiveness. Russia and its people provide the visitor with a new field of observation and study. He sees at every turn something that differentiates this land from the more frequently trodden ways of the tourist in Europe, and often, something more picturesque, and he escapes from barrel organs, German bands, and the whistling boy with his Ta-ra-ra-boom-de-ay.

Perhaps the scenery of the country possesses less individuality than is to be noticed in the towns. From Wierbalen to St. Petersburg and so on to Moscow one travels over a land as monotonous of feature as is the greater part of Germany and France and Belgium. No mountains, no hills are to be seen. The Surrey hills would be as the Himalaya compared with any undulations I saw between Wierbalen and Moscow. Arable tracts (like those of the continent generally, unadorned by hedgerows and undivided into fields, otherwise than by a low ridge or furrow) alternate with wide stretches of pine and birch woods that can hardly be dignified by the term "forests." There is not, in fact, that to be seen which would repay constant regard from a railway carriage for thirty hours. But when we reach St. Petersburg or Moscow there is more than enough to be seen and enjoyed.

It was almost sufficient compensation to us for our journey, that on reaching the confines of Russia we seemed to have passed from a torrid into a temperate zone. We left England at a time when a heat wave was passing over western Europe. It was very unpleasantly warm in London when we started, it was painfully warm as we travelled through Belgium, it was almost unendurably hot during the day we halted at Berlin, but on arriving at St. Petersburg, we found a climate delightfully fresh and dry and bracing, in which we revelled for eleven days, ten of which were gloriously fine and clear, with the exception of a short thunderstorm.

We were agreeably struck, too, by the dustlessness of the place and the peculiar clearness of its atmosphere. The former I attribute to

the character of the road-paving, which, with a few exceptions in the way of concrete or wooden blocks, is of cobble-stone always; the latter is due, I suppose, to the less smoky nature of the fuel employed (*i.e.*, birch and pine) and the more favourable conditions of the atmosphere as regards the dispersal of smoke.

But the absence of macadamised or gravel-strewn wood pavement, greatly as it conduces to one's comfort in minimising the dust supply, has its disadvantages. Crossing those cobble-stones from one block to another is as pestilential a proceeding as a pilgrimage with unboiled peas in the pilgrim's sandals. This, I suppose, explains why few people above the rank of *moujik* are to be seen walking the streets. But a dilemma occurs when one has to determine upon the alternative of driving in a droschky: the degree to which that vehicle shakes one as it rattles over the cobble-stones being almost enough to convert the rider to pedestrianism, even without taking into account the chance the rider runs of being hurled out by an extraordinary jolt over a rut or hollow, or the too rapid turning of a corner: for your droschky is, as a hybrid, part dog-cart and part perambulator, without any restraining arrangement at back or sides that will save you from the effects of centrifugal or any other force that operates to unseat you. Perhaps this is why the male rider often does his droschky-riding with an arm round his female companion's waist; upon which point I am not quite clear, because it appeared that ancient and very uncomely female companions were not regarded as requiring this controlling embrace. Droschky driving, if not luxurious, is cheap enough. The fares descend, I believe, to 10 kopeks (say 2½d.), although only natives may secure a lift at that price; but for strangers they are as low as 15 kopeks, and for 40 kopeks (or 9¾d.) one may drive until one's teeth are almost shaken out.

There are pair-horse carriages of sorts, which may be travelled in with greater comfort than the droschky affords, at somewhat increased fares; there are carriages also with three and four horses abreast (these mostly in Moscow) that may be hired by paying for them; and there are the horse tramcars passing to and fro in every direction. Driving upon wheels of any sort over the roads of St. Petersburg and Moscow in spring or summer or autumn is, however, too noisy and too shaky for perfect comfort. It is in winter, when the sledges glide smoothly and silently over the frozen snow, that enjoyment may be got out of locomotion over street and road, but then the rider has to be covered with furs or rugs and fortified with hot bottles, &c., against a cold that will freeze a man's hat on to his head and convert a lady's veil into a sheet of ice. It is the excessive cold that prevents other than the cobble-stone paving being laid through the towns; large slabs of stone have beem tried, with the result that they were forced out of their position by the action of the frost; and wood blocks, and macadamising, and concrete, have all proved impracticable for that or other reasons.

The visitor who is in St. Petersburg or Moscow for the first time naturally likes to study the place at his leisure, sauntering on his way. There is so much to see that deserves special attention in buildings, and gardens, and the people of the place. The Kremlin, like many Indian bazaars, can only be effectively "done" by the foot-passenger, and even the Nevski Prospect is, to my mind, worth one effort of pedestrianism at least.

Magnificent a thoroughfare as is the Nevski Prospect, I confess I was somewhat disappointed in it. The term Prospect deceived me, and I looked in it, and from it, for some marvellous view, that I did not find. The embankment on the left bank of the Neva (with its broad promenade and gardens, facing a long row of palaces, from which you look across the river upon picturesque fortresses, museums, churches, and other showy buildings that line the right bank) is, in my judgment, very much more attractive. The Nevski Prospect has the merit of being about the longest and widest street in the world, and here and there along its length are cathedrals and other buildings, including a quaint *mairie*, well worth looking at; but the shops are very much as the shops of Paris and Berlin, not being adorned, as are those in humble streets, with signboards or sign-wall paintings indicating the wares provided within by the butcher, baker, and candlestick-maker traders. This is as much a feature of St. Petersburg and Moscow streets to-day as it was of the Strand and Ludgate-hill two centuries ago; but the Nevski Prospect is more modern than its neighbours in this respect.

But in the life of this and other thoroughfares there is much that is new to the visitor, and quaint, and often picturesque. The national costume has not come down all along the line to the dead level of Western tailordom. The long boot, a sort of Hessian, much wrinkled from below the knee to the ankle,

is common enough, often in conjunction with knickerbockers, a long gaberdine, and a bright red under-waistcoat that descends below the hips. The Emperor, on the occasion of the parade of the Chasseurs of the Guard, wore this sort of boot, greased not polished, and the round, peakless cap of fur that is peculiar to the Russian army. Lads of 13 or 14 wear these boots as a substitute for an early *toga virilis;* even boys of more tender years are to be seen in them, the national foot gear in the case of these younger wearers passing down, I suppose, through a family, or possibly through more than one generation of wearers.

Then there are the droschky drivers and other jehus, in a garb which can only be hinted at, so impossible is it of description by letter-press. One long garment, of the dressing-gown order, envelops the jehu's body, and this is padded-out from the waist downwards, as by innumerable petticoats, apparently with the view of making the driver sit firmly upon the box-seat, which he fills to repletion. If a driver of the better class, he wears upon the breast of his coat an ornament suggestive of the cartridge belts of the Circassians; and, whatever his class may be, he is covered as to his head by a hat with the curliest of brims and a low crown that spreads out as it rises from the head to the extent of 1 in 1.

The harness of the horses driven, whether in droschky, or troïka, or tarantass, is peculiar to Russia. The headstalls, which are without blinkers, and the body-straps are often ornamented with brass bosses; and high over-arching above the withers, is what looks like an exaggerated sort of yoke, gaily coloured and be-patterned, but which is really a bow pulled to the extreme of tension, so that the ends attached to the collar strain away from the horse's neck and so lighten the collar work and save galled shoulders.

The droschky is a mere apology for a buggy seat upon wheels, and so light that it may be lifted with one hand. Indeed, it is by lifting the affair bodily that the driver turns his conveyance when in a tight place.

Breadth of way is not peculiar to the Nevski Prospect. Frequently in St. Petersburg, less frequently in Moscow, one comes upon broad roads and wide, open spaces that impart a sense of freedom. Very far from crowded are the streets and parks of the town; one sees nothing to recall the throngs of the Strand or Piccadilly. Orderly are such wayfarers as one meets, and very rarely is a beggar seen, except at the church porches. But more crowded, although not disagreeably so, are the suburban gardens, the Arcadia and *Jardin Zoolozique*, of St. Petersburg and similar institutions of Moscow, Pavalosk, and elsewhere.

The open air life led by the Russian people in these gardens offers very favourable evidence of the climate of the country. The townsfolk sally forth for an evening at these resorts, just as the Berliners do to the Zoologische Garten, or the Parisians to their Champs Elysées. There is no dancing at these places (so far as I saw), but amusement in other forms is provided lavishly. There is a band, there is one theatre or more; sometimes a large concert room is to be found, sometimes a *montagne russe*, or switchback. There are gaily lighted gardens to promenade in, and illuminated fountains and, invariably, ample provision of tea, and caviare, and vodki, and other refreshments in restaurants or at *al fresco* tables that line a considerable portion of the promenade.

At the Arcadia in the Islands, when we visited it, two theatres were going alternately; one open to the grounds, the auditorium of which was, therefore, roofed only by the vault of heaven, and the free seats whereof were, Hibernically speaking, the standing room of a broad space fronting the proscenium. The other theatre was more exclusive and better protected from the elements: it was closed in from end to end, and admission to its stage delights was only to be had upon payment at the door. But the company that played at the one played at the other, and the entertainment of the more pretentious theatre had the drawbacks of being stuffier and more expensive without any compensating advantages.

We found the people of the audience more interesting than the performers of the stage. They enjoyed themselves in such an orderly manner: it might be said almost that they took their pleasure with quite a British sadness. Whether seated at the *café* tables or parading the grounds, they were quiet, mannerly, and respectable; no roughs, or native 'Arrys, or loud if not coarse-mouthed 'Arriets were there to disturb the public peace and prevent the public enjoyment; no policeman was in evidence; no woman who might not have dared the scrutiny of the London County Council reformers. So was it at Arcadia, and the *Jardin Zoolozique*, and the *Vauxhall* of Pavalosk, and the Petroski-park of Moscow, all of which I saw. So is it at the *Zoologische Garten* of Berlin.

I only noticed one thing in any of these

Russian gardens to which I am in the least disposed to take exception—that is, the unnatural character of the Polar bears' environments in the St. Petersburg Zoo. Two of these unfortunates are confined in a cage, immediately opposite a concert-hall, and exposed to the full glare of the electric light. I think of the awful contrast between their natural habitat in Polar seas and this prison home—there, silence broken only by the roar of the wind and the crash of ice-floes: there night unillumined, save by the stars of heaven: there solitude rarely, if ever disturbed by man. Here the roar of brass and human voices, night converted into day, and all day long and half through the night a crowd of people who, respecting not the privacy of bears one whit, thrust bread or buns upon the prisoners' notice. I suppose it is due to this treatment that one of the two Polar bears in this garden is more thoroughly domesticated than any animal of the sort that I have ever seen. It will come, in response to a call, up to the cage front, and accept any edible offered to it by the caller. The St. Petersburg people, also, do a good deal of outing upon the river. In the winter this takes the form of skating and sledging, both of which amusements are described as glorious. In the summer, steamers ply backwards and forwards, up and down, and across the river, and enable the pleasure seekers to do Constradt, or the Islands, or the Gulf of Finland, the last being much resorted to for observation of the sunset. These steamers, like the tramcars, ply from all the gardens of the Islands, up to the time that these gardens close, a time that I could never ascertain, because I could not last out until the time of closure. I succeeded only in ascertaining that St. Petersburg is not in bed at 2 a.m., but did not discover at what hour a Russian night out of bed is supposed to terminate.

Then, again, there is open-air life of the most enjoyable order at Peterhoff, where in villas round the Palace demesne the St. Petersburgers spend their summers. There is here a splendid park in which the public are free to wander down to the waters of the Gulf of Finland; there is the Palace which may be seen; there is Marly at the margin of the brackish sea, with its many momentoes of Peter the Great, including the bed upon which he slept, with his bedding and nightcap and slippers, as they were when he ruled over the empire and dreamed of his carpentering experiences at Deptford.

For the visitor there is much enjoyment to be had other than that of the parks, and gardens, and river. The picture galleries are well worth seeing, even by him who has "done" Rome, and Dresden, and the Louvre. The Hermitage gallery of St. Petersburg boasts, it is said with some reason, of the finest collection of the Dutch school in the world. Here are Rembrandts, Wouvermans, Paul Potters, Teniers, Berghens, Van Osts, Ruysdaals in numbers not to be seen elsewhere. There are, also, more of Murillo's pictures than I remember having seen elsewhere, many other pictures of old masters, and a splendid collection of engravings, of which many are old English ones that should be interesting to the Briton. Then in The Hermitage is a splendid collection of arms, armour, jewels and many an interesting relic of Russian history and wars. Here, as elsewhere in Russia, Peter the Great and Catherine II. predominate. Here are to be seen a life-size model portrait of the great founder of St. Petersburg and the Russian Empire; literally and physically great, this monarch of six feet eight inches or so in height is here shown in his habit as he lived, and his printing press, and turning lathe, and standing writing-desk (out of writing-reach of a six foot man), and walking sticks, and snuff-boxes, &c., &c., are here. And here are the snuff-boxes, and jewels, and saddles (to be ridden *en cavalier* and otherwise), and a long *et cetera* of the great but too liberal-hearted Catherine II. And there are jewel-bedecked saddle-cloths looted from the Turks that are worth a king's ransom, and constitute for the lady visitor an almost irrestible temptation to petty and yet magnificent larceny; and many other things well worth seeing if less terribly tempting.

But, *qua* picture gallery, I think I prefer the modern section of the trans-Neva gallery—*l'Academie des Beaux Arts*. Russia has now for some time come to appreciate her national writers, and she seems to feel similarly towards her painters, and to encourage them accordingly. The collection of landscapes by Russian artists here is an exceptionally fine one; and, I confess, was more enjoyable to me than last season's Academy or the *salon* exhibition. There is in Moscow a private gallery in which are many modern paintings, more of *genre* than landscape. This gallery is open to holders of tickets of admission that may be easily obtained. Here are some terribly graphic delineations of the horrors of Siberia and Russian warfare; and illustrating the worse

side of war, there is a remarkable picture (a pyramid of skulls, over which ravens hover) styled "The Apotheosis of War," which is dedicated to military heroes past, present, and to come. A grimmer satire would be hard to find.

Within the Kremlin, and close to the Emperor's Palace and the Izen Kolokol, or Emperor of Bells, that lies broken on the ground where it fell from the tower years ago, is the Moscow Treasury, a worthy rival as a museum of the St. Petersburg Hermitage. Here are more Polish relics than are to be found elsewhere in the world. Arms, armour, crowns, and sceptres, borne and worn by the ancient enemies of Russia, are here in numbers as trophies of that conquest which cost Russia so many years and lives. Moscow, as being peculiarly close to Poland, suffered more than other parts of Muscovy from Polish aggression, and glorifies its final victory here in the Treasury. Looking at these trophies wrested from their foe, they can remember complacently enough that Polish siege of Troitsa in 1608-9, which lasted 16 months, and many another struggle when the issue 'twixt Pole and Russ hung suspended in the balance.

Here, too, is the most interesting collection of old carriages that I have ever seen. A state coach presented by our Queen Elizabeth to the Czar, another with panels painted by Watteau of a later period, and half a dozen others: and all of these have borne czars and czarinas and princes and courtiers, and all are as splendid in decoration as they are uncomfortable. There are, too, a carriage of Napoleon's (what national museum is complete without this?), the camp-bed upon which that modern Cæsar slept during his disastrous campaign of 1812, and other trophies of that time.

Then within the walls of the Kremlin are shrines and churches innumerable; the palace occupied by the Romanoffs when they were *boyars* only, and the Rurik dynasty ruled in Russia; other palaces of old-time nobles; and everywhere, in places thrown open to visitors, relics and curios that bring vividly before him who sees them the semi-barbarous past that must have been as uncomfortable as it was showy, and is now interesting. Noticeable in those Boyar mansions are the rooms that had evidently been council chambers, where the nobles met, probably, to conspire against the Czar or each other, and the extreme lowness of the archways by which progress had to be made from one room to another—a style of architecture that I concluded to have been adopted with the idea of preventing a sudden attack upon the inmate from without.

Also, within the Kremlin, besides many small markets in narrow roadways, where leans-to from the Kremlin's wall and hucksters' stalls provide the shops, there is a monster bazaar where trifles Russian may be bought as reminiscences of one's visit. I confess that what I saw there did not tempt me greatly; in fact, I should classify such things as came under my observation in that bazaar as rubbish; but it was Russian rubbish, whereas, in the monster bazaar of the Nevski-prospect, at St. Petersburg, the goods exposed are frankly of the Lowther-arcade order.

We saw all these things, and many others of interest, under very favourable conditions as to comfort, and at a cost that was certainly not extravagant. A German guide-book, that gave much advice as to the manner of living in Russia, had informed us that the minimum cost of living in a Russian hotel was 12 to 14 roubles a-day per head. No doubt, if one drank champagne at 10 roubles a bottle, it would be very easy to exceed 14 roubles a-day; but, refraining from the more costly wines, one may easily live for about half that German's maximum. A very tolerable suite of bedroom and sitting-room may be had for 4 roubles a day: tea or coffee, with bread and butter, served in one's room, cost 75 kopeks; an excellent *table d'hôte* dinner costs 2½ roubles; and these are prices quoted from the tariffs of the best hotels.

Those 2½ rouble *table d'hôte* dinners, and many banquets that we attended, opened up to us a new gastronomic world. "The Girl in the Carpathians" speaks approvingly of the novel and taking cookery of Galicia; and, from what she says about insinuating flavours, succulency, and so forth, I fancy that the methods of the Russian *chefs* must be very like those of tne Galicians. There are agreeable surprises awaiting the unacclimatised stranger at every course. The *hors d'œuvre riches* are so rich and so many, that I can well believe the story told of the Jap who, at a banquet given at the Emperor's palace, attacked the *hors d'œuvres* spread out in an ante-room, in the belief that they were the whole dinner; who had beer served to him, at his request, because it was with beer he rounded off his dinner, and only moved on to dine when he had incapacitated himself for that performance. The soups, including a strong preparation of fish and one of much

cabbage, are rich and full of delicate and strange flavours; and, with the soup, are served *petits pâtes variés* (I quote from a *menu*), that are triumphs of pastry like unto miniature meat pies, appropriate to the Court feasts of Oberon. There are the admirably served fish, with their piquant sauces, culinary triumphs of themselves, sufficient to make a decent reputation for the Russian cook: and the fish are admirable *au naturel*, particularly the sterlet, brought away alive from the Thirza in the Volga, and kept alive in reservoirs, with many other finny creatures, in St. Petersburg and Moscow. We saw one of these tanks, or series of tanks, at Moscow, and were introduced by the Vice-Consul to the proprietor, a millionaire (I suppose a rouble millionaire), who combines the retail trade in sturgeon, sterlet, and other fish, with a large business in game and meat. That millionaire condescended to shake hands with me—a further instance of that levelling down of which I have spoken. Of the *entrées* and *rôtis*, it need only be observed that mutton is rarely seen on the Russian table, and that other meats are agreeably tortured out of their natural character, Then comes game, served on occasion in large dishes as a holocaust of mixed birds—hazel-hen, woodcock, solitary snipe, and very young capercailzie, this last being a speciality, I believe. Then is the feast concluded with excellent ices, sweets, and pastry, the *petits gateaux* at this stage being pendants, as it were, to those which went with the soup.

This description applies with nearly equal accuracy to our two-and-a-half roubles hotel dinner, and to the feasts spread for the delegates in palaces and mansion-houses. And, apart from the living arrangements, the service and accommodation of the Russian hotels is very creditable. It is true that, when we were drafted off to the Hôtel Loskoutnaïa at Moscow by the Congress officials who managed the distribution of the 250 delegates, we were somewhat dubious as to the result. The Hôtel Dusseaux, as being peculiarly affected by English and Americans, was the hostelrie we wished to go to; we were sent instead to an hotel where everybody but the superintendent spoke Russian only, and the superintendent spoke only Russian intelligibly; and we never regretted being sent there. Inconveniences there were to be encountered, doubtless. It took us two days to commit the name of our hotel to memory, and we never reached anything like the proper pronunciation of it—indeed, only an Englishman with a cold in his head, who is about to sneeze, could pronounce it. Then, as often as not, our orders had to be interpreted to the servants by the superintendent, to whom they had to be communicated by roundabout forms of speech, eked out by signs. And yet we were perfectly satisfied; our rooms were very bright and clean, and comfortable in every respect; that superintendent was at our beck and call any time from eight a.m. to two a.m.; and with a minimum of intelligible speech we obtained a maximum of our requirements. Nor was it only in the Hôtel Loskoutnaïa that we won our way and our object, in spite of linguistic defects. Wherever we were, St. Petersburg, or Moscow, or where not, we worried out of people who understood us not in speech such guidance as we needed. Our courage in this respect, I think, deserved all praise — and what about the patience of those we worried?

Of that superintendent's kindly attention to us, I cannot speak in too cordial terms. What does it matter to me that he may have been connected with the police of the country? He was lavish in his attentions, and, apparently, overwhelmed by an insatiable desire to bestow gifts upon us. He commenced with the offer of a pound of tea—a special tea—that I had some difficulty in declining; but on the last day, and even after I had paid my bill (and not a heavy bill by any means), he persisted in presenting to us a Moscow *plaque*, a pair of locally-made ash-stands, and a set of Moscow postage-stamps. I can hardly conceive that he did this with the object of improving his French by conversing with me, his French and mine are too hopelessly unimproveable to admit of that explanation, and there is no other possible under the circumstances than honest good-will.

There is about the Russian banquet something besides the gastronomical features that might well be imitated in this country, *i.e.*, its brevity. The Imperial banquet to the Delegates at the Winter Palace was a marvel of expedition; we sat down at 6.30 p.m. and all was over before 8 o'clock—*ab ovo usque ad mala*—done in less than ninety minutes. On that occasion there were no speeches and only the one toast, "The Emperor." But speechmaking is not allowed anywhere to protract the Russian banquet greatly, if at all. They do not wait there until the dinner is finished and the coffee and liqueurs put on the table; the toasts begin while the fish yet lingers on

the board, the orators orate amidst the clatter of plates and clink of glasses, none but a few enthusiasts, who leave their dinners to crowd around them, hear one word of what they say, and by the time that the dessert is reached the orators have spent themselves, and the guests are free to disperse, free also to break up and carry away with them the flowers that have decorated the board in high-piled trophies.

Whether one be a *gourmet*, or a traveller with a healthy appetite, or one with small and fastidious feeding capacity, the Russian *cuisine* ought to give satisfaction; and many of those comestibles and drinks that come as novelties upon the stranger encourage him to become better acquainted with them. As to those novelties, which are especially of the people — the peasants, and artisans, and labourers—such as kvas, buckwheat *galette*, and gribuis (dried fungi), my researches reached them not. But Russian tea, as it is drunk by prince, and peer, and peasant, is, in my opinion, a dismal substitute for the cheering cup as it is known in England; and herein was one of my few disappointments; I expected great things of that tea which is transported overland, in brick or otherwise, from Kumâon, manufactured with the aid of a samovar, and served with a slice of lemon instead of cream—I realised so little of my anticipated joy, that I abstained from tea altogether after the first day or two. Nor can I consider it a success, as tea, with the Russians themselves; it is only an excuse for the hot-water cure recommended for dyspepsiacs, the infusion, made in a small tea-pot of a pint measure, being diluted again and again with a gallon or two of hot water, without any thought of adding fresh tea.

The tea at the railway restaurants is one of the worst features of Russian railway journeys; indeed, it is the only unfavourable feature that was impressed upon us. The restaurants themselves are palatial buildings, with reasonably good service. One is allowed to stop in them at meal times long enough to eat something; the stations have ample accommodation in the way of waiting-rooms, &c.; and attendant ticket porters who can be left to get one's luggage with some confidence as to their and its appearance in the fulness of time. Here, as on the Continent generally, the traveller receives a receipt for his luggage, in which weight and number of packages are given, a system that would not be without its advantages in England.

Russian railway carriages are, as a matter of course, fitted up with conveniences tha here are a matter of luxury. A gangway run through all the coaches from end to end o the train, and well-appointed lavatories ar accessible to all 1st and 2nd class passengers Many 1st class compartments are *coupés* fo two; some much larger ones are fitted witl massive and very comfortable arm-chairs (de tached), which can be converted into cushione bedsteads. Most of them have ample conve niences of racks, &c., and a handy hinge flap on the door, that may be put up an secured, to serve as a table for a lamp o cards, or what not. And in these trains on travels at a leisurely pace, over roads that ar innocent of sharp curves and steep gradients with a minimum of jarring and jolting, an with appliances at hand for washing off th dust of travel.

These remarks about Russian railways while bringing this sketch of my trip to a close, aptly remind me of the *raison d'être* o that expedition, and suggests the questio whether the foreign delegates who come t England for the International Railway Con gress of 1895, will have reason to be a grateful for their reception here as I am fo that accorded me by Russia.

Referring to the official *Programme d l'Emploi du Temps* issued to the delegates o the Congress of 1892, held in St. Peters burg, I find the following entertainments se down for the idle hours of that body:—20t August, banquet given by the Minister o Railways, &c. 21st August, 11 am., steame excursion to Cronstadt, and *déjeuner* o board, offered by the Russian Administration At 9 p.m., banquet given by the Municipa Council at the Hotel de Ville. 24th August at 4.30 p.m., excursion by rail to Pavlosk and banquet at the Vauxhall (followed by a ban concert in the Pavlock-gardens) given by th Russian Railway Administration. 26th August excursion in many steamers to the Isles, an gala representation at the Theatre Arcadi (with refreshments in the Arcadia-gardens) 27th August, excursion to Peterhoff, and *th offert aux membres du congrés au Pavillo Mon Plaisir, de la part de la Cour Impérial* (the tea offered being less accepted than th champagne and other wines which also wer offered, together with artfully constructe sandwiches, cakes, &c.) 150 Court carriage conveyed the congress, with sisters, cousin and aunts, from the station to Peterhoff an Mon Plaisir, and through the park back to th station. 29th August, an (interpolated func

ion review) by the Emperor of the *Chasseurs de 'a Garde*. 30th August, expedition by the Finland Railway, leaving St. Petersburg at 3 a m. Minor banquets at Viborg, going and eturning, and a more ambitious one at matra. Refreshments on a liberal scale at very station *buffet*. The return to St. Petersurg timed for 30 minutes after mid-night. st September, railway journey to Moscow, with nlimited refreshments by the way. 2nd eptember, at noon, a banquet styled *dejeuner*, iven in *les salles de l'Assemblée de la Noblesse* y the Russian Railway Administration, folowed immediately by visits to the Palace, 'reasury, and some cathedrals in the Kremlin. t 8 p.m. a gala spectacle at the Grand 'heatre, and at 10 p.m. an excursion to the 'étrowsky Park and Théatre Fantaisie. 3rd eptember, at 6 p.m., banquet given by the Iayor at the Hotel de Ville. 4th September, xcursions to Nijni Novgorod and Kief, with iore banquets there and by the way given by ie Railway Administration. And, as a part f our entertainment not mentioned in the rogramme, excellent pair-horse carriages ere placed at the disposal of the delegates iroughout their stay at Moscow.

Before I sit down, let me explain that I do ot pretend to have presented to you more ian the most superficial view of Russia and ie Russians. Beneath the fairly smooth surce that I have described there doubtless tists much of evil that one would desire to e reformed, and much of wrong that one ould wish to see redressed; but of that amy side the tourist sees little, and I have ily endeavoured to depict that which, as a urist, I saw.

DISCUSSION.

Mr. G. N. Hooper said Sir Edward Braddon had id a most interesting paper, which, he (the speaker) ped, would induce more English to visit Russia. was induced to do so in 1856 for several reasons: e was to see the country on the termination of the eat war, in which some of his relatives had taken rt; another was the coronation of the late Emperor, exander II.; and a third was his great desire to the celebrated art collections of the Hermitage lace in St. Petersburg. He had some boating on Neva, but in that he was rather disappointed, there were so many shoals and the boats unded so often that he was glad to get to land in. He should like to emphasise the remark de in the paper as to the magnificent bass voices he priests, which were something wonderful, and ost worth a journey to Moscow or St. Petersburg to hear. It was also very interesting to see the colossal public buildings at St. Petersburg, and also the monuments, especially that of Peter the Great, which stood on an enormous block of stone brought from the Finland quarries. It was wonderful how it could have been transported at all, and reminded one of similar exploits in connection with the Pyramids of Egypt. Then there was the red granite column of Alexander I. Another interesting sight in the same city were the numerous fire-brigade stations and watch-towers. Many of the houses were built of wood, and these towers were dotted about the city with sentries always on the top, to give the alarm as soon as a fire was discovered. The mode of communication from the top of the tower to the bottom was very ingenious; there were tubes, down which brass balls were sent, and in the ball was inserted by the watchman of the locality a written memorandum indicating the fire, so that assistance could be sent without delay. The Imperial stables formed another of the sights of the city; in them were to be seen some magnificent horses of the Orloff breed; he would not say they were equal to English, but they were a very fine breed of horses. He thought that on the occasion of great international exhibitions, public ceremonials in foreign countries, such as coronations, or festivities of any sort, visitors received more attention and had opportunities of seeing more than ordinary tourists. He might refer to the very artistic illumination of the city at the time of his visit. Instead of being done confusedly, as in England, a general plan was laid down for the decoration of the streets, the public buildings were illuminated at the cost of the Government, and the effect was very grand. A troublesome ordeal was the frequent viséing and investigation of passports. He made a note that between leaving London and returning, his passport went through 24 different hands, and he had to wait at St. Petersburg while he obtained permission to get his railway ticket for Moscow, and again at Moscow before he got permission to return to St. Petersburg. Before he could leave Moscow he had to get a certificate that he had paid all his debts, and the same thing happened in St. Petersburg before he was allowed to leave the country. Another hardship to English travellers was the censorship of their books. He took with him two or three guide-books which he thought would be useful, but on arriving at Cronstadt they were impounded by the Custom-house officers, who, however, said he could have them again on leaving the country. He protested that they would then be of little use, but was only told they were forbidden; he could, however, call on the censor. He did call, and received the same reply; but on leaving was followed by an official who inquired if he really wanted them, and on ascertaining how much he was willing to pay, said he would bring them to his hotel in the evening. In visiting Moscow he was much struck by the great respect paid to things considered sacred. There was a sentry

always on duty at the holy gate of the Kremlin, to see that every one took off his hat in passing through, with orders to arrest anyone who refused to do so. He could not quite agree with the statement that there was only rubbish in the great bazaar at St. Petersburg. He saw there very fine Russian furs, and also beautiful gold and silversmiths' work. The Russians are very clever at bronzes, and there were some splendid specimens of colossal size on the corner towers of the cathedral of St. Isaac. One of the entertainments at Moscow in connection with the coronation was a banquet to 250,000 persons, laid out on the steppe. The tables radiated from two centres, where there were fountains, which, he was told, were to play with gin; but he did not stop to verify the statement. There were to be 4,000 sheep roasted whole, and, when cooked, their tails and horns were to be gilt. Some of these were already on the tables. However, he heard that, in consequence of the signal being given prematurely (before everything was ready), the first comers seized on what they could lay hold of, and the banquet began and ended with a scramble, in which many got nothing to eat. With regard to the tea, which he tasted, it was remarkably fine, and the aroma quite scented the room. He was shown some which was sold at 30s. a lb., packed carefully in pretty boxes, lined with white satin. The refreshment rooms at the Russian stations were superior to anything he had then seen. At Moscow, there were horse races, at which the English horses and jockeys carried everything before them, when allowed to compete; but there were other races, limited to Cossacks, Georgians, and other tribes, which were of a totally different character. He was much struck with the large, heavy, and cruel bits, which pulled up the horses suddenly, but seemed to inflict great pain upon them. After the race, there were exhibitions of Russian horsemanship, the rider dismounting and picking up a handkerchief, and remounting while going at full speed. The necessary visit to the office of the secret police in St. Petersburg took up (and wasted) much time, waiting one's turn for an audience. The officer politely asked for my object in visiting Russia, and, after many questions, seemed rather amused that an ordinary tourist should make so long a journey for the sake of acquiring information of which there was no officia need. Interesting papers might be read on visits to some of the great fairs in Russia, especially to that of Niji Novogorod ; and on steamboat trips in Russia as well as on trips to Finland or Siberia. This could now be accomplished with less trouble and inconvenience than he had to undergo in 1856.

Mr. MALLETT asked if English travellers were subjected to much inconvenience at the Customs on entering Russia, as they were in Turkey. He should also like to know if Sir Edward Braddon met with any of the miraculous pictures which were sometimes exhibited in Greek churches. He had seen them in Turkey, and was told they were found in Russi also. The picture was simply stretched, without frame, and placed on an easel in the body of th church. There was a money-box below, with a sl in it extending the whole width of the picture. Th visitor could examine the picture and feel it withou detecting anything remarkable, but there was th wonderful property, that a coin placed on the surfa remained there for a considerable time. If yc attempted to remove it, it fell into the money-bo and the curious thing was that silver coins adher better than copper, and the heavier they were, tl longer they remained.

The CHAIRMAN said Russia was really little know to Englishmen. That country is distant, and n easily accessible, and ordinary travellers experien difficulty in getting about. Strangers who go the on special occasions enjoy, of course, facilities whi ordinary travellers do not possess. The history Russia is very interesting, but in its earlier stages had little or no direct connection with our own co munications with Eastern Europe. At one peri there was greater promise of the development social life in Russia than in England. At the ti of the Norman Conquest, town life in Russia w even more advanced than in England. The wh aspect of the case, however, soon became change for the Tartar Conquest which ensued, like a glac period, submerged all that had gone before, a swept away the results of early progress a civilisation. Long continued wars completed th disasters. The history of this era presents ma dramatic and strange incidents, but in those centur the people inevitably became, to a large degr deteriorated. One incident might be mentioned, t remarkable case of the pretender, the false Demetri a man who passed himself off as the heir to t throne, who was dead; obtained a number f adherents; and carried on a kind of governm for several years, bringing about the war wh culminated in the great siege of the Troitza Conve, lasting for sixteen months, but which, when it w over, relieved Moscow from the presence of a forei enemy for upwards of two centuries, until advance of Napoleon. In Russia alone the title f the Cæsar still survives, the name of the great Ju being perpetuated in the title of the ruler of Russian empire. The people are kind-hearted a orderly, and the policy of the country is continuo. They know what they want, and have great tena of purpose, which in the past has enabled them accomplish what they wished, and would very lik do so in the future. He concluded by proposin hearty vote of thanks to Sir Edward Braddon for admirable paper which he had read, which wa valuable addition to his former contributions to Society's transactions.

The vote of thanks having been carried,

Sir EDWARD BRADDON, in reply, said he was una

› answer the question as to the miraculous pictures. 'e did not see any silver coins in Russia at all, nor d he try the experiment of applying coins of any nd to any of the pictures he saw in the churches. e was not able to say whether Russia was more vere than other Continental countries with regard Customs' arrangements, because he went under ry favourable circumstances, and his baggage was ›t examined. He was thus able to smuggle erature into the country which otherwise might not ve passed. He was in some trepidation with gard to "My Official Wife," which he thought ›uld not be appreciated in Russia, and carried it er the frontier in his coat pocket; but, ultimately, ıen he found that no one seemed to care what he d with him, he left it openly on the hotel table, t did not know whether any one read it. With gard to passports, and very likely other matters, ›re was more liberality now than formerly; and in case there was absolutely no trouble. There s no question about their being in debt to any when they left, because the hotel people were only ones to whom they could be indebted, and y held the passports and only returned them en the bills were paid. With regard to the tea, could only say that he never came across any h any aroma at all, except that of hot water. ıt might have been because they went about in a ge party, and a small quantity of tea had to serve too many people.

'HIRTEENTH ORDINARY MEETING.

Vednesday, March 8, 1893; Professor C›EMENT LE NEVE FOSTER, D.Sc., F.R.S., Imber of the Council, in the chair.

'he following candidates were proposed for e:tion as members of the Society:—

Insom, William A., New Church-road, Brighton, ussex.

F›ons, Frederick, Newport, Monmouth.

he following candidates were balloted for a duly elected members of the Society:—

Btow, George Ledgard, 1, Copthall-buildings, .C., and 2, Cedars-road, Clapham-common, S.W.

P.mor, John, Rickmansworth, Herts.

Rker, James M., 12, Great Tower-street, E.C.

he paper read was—

USIC IN ELEMENTARY SCHOOLS.

By W. G. McNaught, A.R.A.M.

January last, I spoke at a meeting of the Irrporated Society of Musicians on the p:ress of music in elementary schools. I knew that many of the facts and circumstances connected with musical education in schools of this type were unknown to my professional brethren, and I thought they would be interested to have placed before them a succinct and comprehensive account of the whole business. At the invitation of the Council of this Society, I intend to-night to briefly recapitulate the observations I made on that occasion, and to discuss other points that were beyond my former purpose to bring forward.

First, I draw your attention to the vast number of children now under the influence of the Education Department.

STATE-AIDED SCHOOLS IN ENGLAND AND WALES.

Number of Children on Register.

Age.	
1. Under six	960,011
2. Six to twelve	3,307,588
3. Over twelve and under thirteen.	380,367
4. Over thirteen	185,363
Total	4,833,329

Average attendance, 3,754,493

Observe the great number of children under six years of age. No serious study of music or of anything else can be undertaken before or at this tender age. But much may be done in awakening musical sense, and in instilling a love for music. In view of the after-life of the school child, it is far more important to observe that there are comparatively few children over thirteen years of age.

If we are to arrive at common-sense conclusions as to the possibilities of music in these schools, we must consider as fully as possible the capacity of the raw material upon which we have to work, and the machinery with which, whether we fully approve of it or not, we must do the work. We must be careful to separate the ideal from the practicable. We must realize what can be done in view of the inevitable conditions under which we must at present, at least, continue to work. Further, in view of whole necessities of the nation, we must be careful not to claim too high a place for music in the average child's curriculum. We are bound to admit that other matters must have equal if not more attention.

The main factors to be considered are:—(1) The musical capacities of the children; (2) the teaching power available; (3) how the teaching power is trained; (4) how and by whom the schools are examined.

The Musical Capacity of the Children.

What is the criterion of the musical capacity of groups of children? I take it to be the power of quickly picking up songs, and of singing them in good time and tune, and the power (when they are adequately taught) of associating symbols with things in music. Judged by this criterion, I think it is fair to claim for our children as quick a capacity as the children of any other nation have been shown to possess.

It is, however, difficult to form a trustworthy estimate of the convertible musical capacity of the children in our schools. Only a limited time can necessarily be allotted to music, and we are by no means assured that the circumstances under which most of the schools are taught are calculated to properly develop musical capacity. We only know what *is* done, and we can but guess at what *might* be done. In some country districts it would seem that the average musical capacity is deplorably slight, whereas, in some of the larger towns, the children accomplish astonishing feats. This apparent disparity of capacity and actual disparity of attainment undoubtedly arise, in a great measure, from the superior skill possessed by many teachers in town schools. It would be an interesting experiment to send a few dozen of the best singing teachers from the London School Board to one of the worst country districts for a few years, and thus ascertain whether the capacity there is merely latent.

All expectations as to what ought to be accomplished in average schools must be tempered by the somewhat depressing fact that very few children (about 4 per cent. of the whole total) remain under instruction after they are 13 years of age.

Teaching Power.

The school music teaching in England and Wales is almost invariably committed to the care of the ordinary school staff. We cannot reckon upon this system being altered. Public opinion, in England, at least, with reference to music, is not educated to the point of tolerating the great cost that would be incurred if the schools generally were taught music by visiting specialists. If all the children in the London schools were taught in this way the cost would probably be £50,000 a year, and it is very doubtful whether such teachers would secure better results than are now obtained in town schools. The fixing of the responsibility for the music teaching upon the school staff has, in many districts, developed the most remarkable trai ing capacity. To give up this principle wou deprive 80,000 teachers of a motive to impro themselves musically.

The circumstances of the small schools the country districts present a great difficult There are 5,582 schools in each of which t attendance is less than 60, and where t average salary of the single teacher employ to teach *all* subjects is probably never ov and often considerably under, £70 a year. T reasonableness of not expecting much fr these schools is very apparent. The teache are generally untrained and, although I w not say incompetent all round, are rarely al to teach music efficiently. The difference b tween the note-singing grant and an ear-sin ing grant amounts to so little—30 shillings year on an average attendance of 60—we ca not expect monetary considerations to stim late the teachers in these schools to attain t best results.

The Musical Training of Teachers

The next point I bring before you is t means available for the training of teachers teach music. The importance of this co sideration is obvious. Eighty thousand sch l teachers have it in their power, if not to ma , then, at least to mar, the ear of the nati . Their fitness for the work is the key of e position.

The future teacher generally begins s scholastic existence as a child in the e- mentary school. If he successfully passes e ordinary school examinations, he becomes a pupil teacher, and lays himself out for n annual individual examination. He contin s in this stage for four years. At the end f each year there is an optional paper exami - tion in music, and quite lately a new optio l practical examination has been institut . From this practical examination we hop a great deal. Hitherto, numbers of pu l teachers have neglected the practice of mu c because they could gain nothing by pursu g it, but now that it counts in the race for ma , there is no doubt that far more attention ll be devoted to the subject.

The next ambition of the would-be teac r is to secure admission to a Training Colle . There are now 52 colleges, in which, mo y at the expense of the State, nearly 4, 0 students are trained for two years. The co- petition to gain admission is very severe. L st year there were nearly 11,000 candidates or the 1,700 vacant places. Of course, the coll e

thorities choose the best they can get. ısic, both practical and theoretical, counts the entrance examination, but not for very ch. The rejected are compelled, as a rule, put up with the inferior posts in schools. this way it comes that there are 21,000 rained teachers and 26,000 trained teachers present working in the schools. It is, of ırse, the untrained teachers who find their y to the small country schools. We cannot without them, and we have to learn to ke the most of them.

)ur greatest hope for the future lies in the ıeral excellence of the music teaching in t Training Colleges. Many of the best class zing-teachers of the day devote their abilit and time, with the most gratifying ardour, t the students in these institutions. The c ral performances given at the annual inspect ı are often of the highest order, the most d icult music being admirably performed. M ch of the recent progress of music in s ools must, unquestionably, be attributed to t lessons in culture and taste assimilated by s lents during their life in the Training C ege. Before leaving college, each student h to undergo an examination in sight singing, s singing, and ear training. This exa nation is individual, and is conducted by S John Stainer or his assistant. A fairly st paper examination is the last test to which tl student has to submit before he becomes a re gnised teacher by the Education Departm t. It must be noted, however, that he m obtain his ordinary teacher's certificate w out having passed any of the whole series of nusical examinations. The number of te hers at work, or under training, is as fo ws:—

Teachers Acting and in Training.

Certificated teachers		47,823
Pupil teachers, 1st year	5,479	
Ditto. 2nd ,, ...	7,247	27,854
Ditto. 3rd ,, ...	7,580	
Ditto. 4th ,, ...	7,557	
Students in 52 training colleges ..		3,806
Total........		79,483

Examiners.

e difficulties associated with the question of aminers at one time occasioned great perple ties. The Education Department did not fee ustified in putting the country to the expe : of appointing a regiment of special mu : inspectors, and it seemed hard to exp :t Her Majesty's Inspectors to undertake the ork. The late Mr. W. E. Forster, when he was Vice-President of the Council, very well described the case when he said:—"That the Education Department fully desired to encourage the practice of singing, but the difficulty was that, 'at present, the Privy Council did not find their inspectors were able to give that thorough examination which they ought to give. The musical education of the upper and middle classes had been neglected, and it was difficult to find gentlemen competent to examine in the notation of music.'" It was clear that no scheme of examination was practicable that Her Majesty's Inspectors could not see their way to administer. Thus, another obstacle to the progress of school music had in some way to be overcome. The practical point was, and still is, how can we make the best of the inevitable? That the music code has, on the whole, succeeded so well, notwithstanding all the difficulties that surrounded its birth, is a gratifying testimony to the ability with which it has been worked by Her Majesty's Inspectors. A regulation to the effect that all Inspectors' Assistants should be qualified to examine in music has helped very considerably the solution of this difficult question of examination. There are, in all, 306 Inspectors, Sub-inspectors, and Inspectors' Assistants.

School Music Superintendents.

Many of the large town School Boards have adopted the wise course of engaging a specialist to advise the teachers how to go to work, and to see that the work is being properly done. When it is considered that teachers have to chose this or that method and apparatus, and to fix the music to be practised and to train young voices, it is obvious that the option of being able to appeal for advice and instruction to a trustworthy superintendent is a very great advantage. But such an officer must not be a nag or a whip. He must be able to make the teachers regard him as a friend and a helper. It is a great pity that the voluntary schools do not unite to get assistance of this kind.

I have now placed before you an account of the chief forces with which we have to deal. I will next ask you to bear with me while I rapidly glance at the recent history of music in elementary schools.

The Education Department, and Singing by Note.

Year.

1867. Grant offered for music teaching by note.

1869. One school obtained the grant.
1870. 43 schools (out of 12,000) obtained the grant.
1871. New Code, music grant withdrawn.
1872. 1s. per head deducted from the general grant if singing was *not* taught. No difference recognised between note and ear singing.
1879. Government inquiry elicited that 2,944 Schools were taught by note, and 21,224 by ear.
1883. New Code, 1s. per head to be paid for note singing, and only 6d. for ear singing. No alteration has been made since.

How far the note singing requirements have been successfully adopted will be seen from the following figures :—

RESULTS OF EXAMINATIONS IN 1884 AND 1891.

Year.	Children taught by Note.	Children taught by Ear.
1884	1,282,586	1,997,572
1891	2,686,138	1,080,513
	Increase 1,403,552	Decrease 917,059

AMOUNT OF GRANTS PAID.

	For Note Singing.	For Ear Singing.	Total.
1884	£64,129	£49,939	£114,068
1891	£134,307	£27,013	£161,320
Increase	£70,178	—	£47,252
Decrease	—	£22,926	—

The enthusiasm for teaching singing by note—or for the shilling grant—is by no means universal. In some districts hardly any attention seemed to be given to note singing, and in others nearly all the schools gain the higher grant. Devonshire is the lowest in the list, and the Metropolitan district stands highest. It is a very remarkable circumstance that the average for England is exactly the same as for Wales.

Highest and Lowest Per-centage of Schools Taught by Ear or by Note.

	Taught by Note.	Taught by Ear.
Devon	15·0	85·0
Cornwall	21·0	79·0
Cambridge	24·0	76·0
Hereford	26·0	74·0
Oxford	35·0	65·0
All Wales	57·0	43·0
Warwick	67·0	33·0
York	72·0	28·0
Stafford	72·0	28·0
Lancaster	77·0	23·0
Middlesex (Outer Metropolitan)	81·0	19·0
London	93·0	7·0
All England and Wales	57·0	43·0

The present requirements (March, 1893) the Music Code are as follows :—

REQUIREMENTS OF THE EDUCATION DEPAR MENT FOR THE NOTE SINGING EXAMINATIC IN MUSIC.

For Schools using the Staff Notation.

DIVISION I. (Infants).—*Note Test.*—1. To sin as pointed out by the examiner, the notes of t key-chord of C *in any easy order*, using the sol syllables.

Song Test.—2. To sing sweetly an easy scho song or action-song previously prepared. Three be prepared.

The compass of these songs should lie betwe C and D, and the words should be such as childr can understand.

DIVISION II. (STANDARD I. AND II.).—*N Test.*—1. To sing slowly, as pointed out by t examiner, and using the sol-fa syllables, the ascen ing and descending notes of the scale of C (*do*), t notes of the key-chord of C (*do*, *mi*, *sol*, *do*), any order, and also small groups of consecutive no of the scale of C as written by the examiner.

Time Test.—2. To sing on one sound, to t syllable *laa* or *doh*, an exercise in $\frac{2}{2}$ or $\frac{4}{4}$ time, wh shall include minims and crotchets.

Ear Test.—3. To repeat (*i.e.*, imitate, not nan a simple phrase of not more than four notes, us the syllable *laa*, after hearing the examiner s (or play) it twice through.

Song Test.—4. To sing in unison, in good ti and tune, and sweetly, a school song (set to wor previously prepared. Five to be prepared.

DIVISION III.—*Note Test.*—1. To sing slowly pointed out by the examiner, using the sol-fa syllab a series of notes in the key of C, containing F sharp contradicted by an F natural, and a B contradicted by a B natural. The F sharp sho be approached by the note G, and return to G, the B flat should be approached by C, and followed by A.

Time Test.—2. To sing on one sound, to syllable *laa* or *doh*, an exercise in $\frac{4}{4}$ or $\frac{3}{4}$ time, c taining semibreves, minims, crotchets, and quav, with dotted minims, and rests on non-accen portions of the bar.

Ear Test.—3. To repeat, and afterwards name three *consecutive* notes of the scale of C which e examiner may twice sing to the syllable *laa* (or pl *each* time first giving the chord or the scale of. The test should commence on some note of the y chord.

Song Test.—4. To sing in unison, in good te and tune, and with due expression, a school-sonr round (set to words) previously prepared. Five be prepared. Rounds or two-part songs may offered in place of unison songs.

DIVISION IV. (STANDARDS V. AND UPWARD. —*Note Test.*—1. To sing slowly, using the sca

/llables, from the examiner's pointing, any simple iatonic passage in the keys of G (one sharp), D (two harps), F (one flat), or B flat (two flats); and also a milar simple passage containing accidentals to raise ıe fourth of the scale (approached by the third or fth) and to flatten the seventh (approached by the ctave) properly contradicted.

Also, to sing in the same way as above described, short passage in the key of A minor, introducing ıe sharpened seventh approached from and leading ı the note A, but without introducing the sixth najor or minor) of the scale.

Time Test.—2. To sing on one sound, one or more ries of notes and rests in $\frac{2}{2}$ $\frac{4}{4}$ $\frac{3}{2}$ and $\frac{3}{4}$ times, which ıall include dotted minims and dotted crotchets; so a simple phrase in $\frac{6}{8}$ time, counting two beats a bar.

Ear Test.—3. To repeat and afterwards name the ›tes of a simple diatonic phrase, consisting of not ore than four notes of the scale of C, which the aminer may *twice* sing to *laa* (or play), each time ving the chord or the scale of C.

Song Test.—4. To sing, in good time, tune, ex- ession, and in a pleasing quality of tone, a school- ng in two or more parts or a round (set to words) eviously prepared. Five to be prepared.

r Schools using the Tonic Sol-fa Notation. (The Ear and Song Tests are the same as for the Staff Notation.)

Division I.—To sing, from the examiner's point- ; on the modulator, the tones of a *doh* chord, *in y easy order*, using the sol-fa syllables.

Division II.—*Note Test.*—1. To sol-fa slowly, m the examiner's pointing on the modulator, in / key—the key-tone and chord being given—the ıes of the *doh* chord in any order, and the other es of the scale in stepwise succession.

Time Test.—2. To sing on one tone, to the syllable ı or *doh* an exercise, including one-pulse and ›-pulse tones, in two-pulse and four-pulse mea- e.

Division III.—*Note Test* (*Modulator*). — (*a*). sol-fa from the examiner's pointing on the dulator, or from dictation, in any key, simple sages in the major diatonic scale, including *fe* and n stepwise progression, used thus, *s fe s— d' ta l.*

Note Test.—(Written or printed.) (*b.*) To sol-fa ›ight a written or printed exercise, including the es of the *doh* chord in any order, and any other es of the major diatonic scale in stepwise succes- .

Time Test.—2. To sing on one sound to the able *laa* or *doh* an exercise in three-pulse or -pulse measure, containing one-pulse notes, half- e notes, and whole-pulse rests on the non- nted pulses of the measure.

Division IV.—*Note Test.* (*Written or printed*).— To sol-fa slowly any simple diatonic passage in major key; also a similar simple passage containing a transition of one remove indicated by bridge notes.

Also to Sol-fa a short passage in the minor key or mode, introducing *se* used thus :—*l se l*, but without introducing *fah*, *fay*, or *soh*.

Time Test.—To sing on one tone one or more series of notes in two-pulse, three-pulse, four-pulse, including pulse-and-a-half notes; also a simple phrase in six-pulse measure, beating twice to the measure.

The Deceptiveness of Collective Examination.

It should be noted that the examination, except in the case of the ear test, is collective. There cannot be any doubt that this inevitable mode of examination does not necessarily imply much individual practical skill. The faculty of almost instantaneous imitation of sounds, possessed by those with even less than average natural capacity, is at once the greatest danger of class teaching, and a cause of unconscious deception in collective examination. It is frequently the case that the whole class can sing at sight what no one in the class can sing alone. But when all has been said against this mode of examination as an adequate test of skill, every reasonable musician will admit that schools, in which sight-singing power is shown, even in this way, have attained a very substantial result.

The answers to ear tests must be given by the individual. Such questions are really a severe test. The majority of fair adult amateur musicians would be embarrassed to face such tests. This being so, it is not expected that every child in a class should be able to answer names correctly. For my own part, I should be quite satisfied if good answers were given by one-third of a well-taught class.

I now propose to discuss some debatable questions that often occupy the minds of those concerned in school music.

1. Should the grant for ear-singing be abolished? I answer that it is gradually abolishing itself. The figures given above prove this. It would be unjust to entirely deprive small village schools of the ear grant. It would do no good, and might do harm. Ear-singing is certainly better than no singing. For generations the masses have been inspired by national songs, learnt entirely by ear. Ear-singing, sweet and in tune, does more for music than lifeless and flat note-singing. It would do no good to irritate the over-burdened country teacher. Keep in mind the difficulties by which he is beset. As it is, the ear-singing schools are being coaxed into

note-singing. If the ear grant were withdrawn, it is more than probable that singing would be altogether abandoned in many schools.

2. Is it advisable to stiffen the requirements? Yes, but very cautiously and gradually. A new departure will be made next April. The higher standards will be required to sing at sight, a test combining time and tune. Hitherto the time test has been tuneless and the tune test timeless—a monotone exercise. It is certain that town schools could, as a rule, pass a much stiffer examination than it would be reasonable to impose upon the country schools. But the differentiation of requirements for the two classes of schools is surrounded with difficulties. At present, at least, it does not seem feasible to alter in this direction.

3. The total amount of the grant, £160,000, looks large, and tempts speculation as to what service such a sum could be made to render to musical art if it were expended in other ways, say, in establishing first rate orchestras in the provinces, where it is admitted they are sorely needed, or in training artists in conservatoires. But it is not quite fair to look at the matter in this way. The amount is large because the number of children is large. The question really is whether £5 a year is too much to pay for the sound elementary musical education of 100 children.

METHODS USED IN SCHOOLS.

(*Number of School Departments.*)

	Staff Notation.	Tonic Sol-fa.	By Ear.
1884	2,396	6,773	18,593
1891	2,362	15,153	11,833
Increase	—	8,380	—
Decrease	34	—	6,760

4. It will be observed, from the above figures, that nearly all the school-teaching by note is on the tonic sol-fa system. It is a moot point whether a knowledge of the staff notation should be required from, at least, the highest divisions in schools; but, in view of the fact that the great bulk of the children leave school before they are 13, I do not think the time is quite ripe for us to insist upon the universal use of the staff notation, even from only upper standards. I would encourage it in every way, and especially in the large towns, but I would not enforce its use. School Boards are very susceptible to public opinion: if they feel the pressure is tending in the direction of requiring staff notation, they have full liberty to act as they please. The Education Department exerts no pressure; therefore I think that, on the whole, it is best that local circumstances should at present decide the question of notation. It should be noted that we have gained our present position almost entirely by the Tonic Sol-fa method. To allow this method to be re-disparaged, or to attempt to do it without it, might result in a falling back rather than in progress.

5. Then there is the question of the choice o music for school use. Complaints are ofter made that the songs and pieces practised are commonplace and vulgar, and it is urged tha only good music by reputed composers shoulc be studied. Mr. Villiers Stanford has pleadec strongly for a systematic use of the old nationa songs of England, Wales, Scotland, and Ireland It is only too true that the recent demand fo music, that is practicable in an elementar school, has led to the supply of an immens quantity of the commonest possible descrip tion. But this same demand has also led to th composition or arrangement of an ample reper tory of school pieces, against which no exceptio whatever should be taken. The present difficult is simply to educate the teachers to choos the good and reject the bad. It is a mistak to urge that so-called "classic" music shoul be used in schools. Very little music by th best composers is adapted for school use. A attempt to force the taste of children simpl ends in a dislike of the whole subject. Wha is needed is well-written, melodious musi chiefly diatonic in construction, and allied t good words, such as the children can unde stand. Of this kind of music, I repeat, there i now an ample supply.

6. The training of children to sing well i tune, and to produce a pleasant musical tone is not nearly so well understood as it shoul be. The greatest difficulty of all in this con nection is the tendency of children to flatte Much could be done to alleviate this evil teachers would make it their business to unde stand how to teach proper breathing and th proper delivery of the voice. But in the ve best circumstances we must not expect tc much, because, as we all know, the fine adult choirs in the world flatten.

THE AFTER RESULT OF SCHOOL TEACHIN

In conclusion, there is one more topic c which I wish to say a few words. I am boun to confess that the after result of the music education given in our schools is somewh disappointing. There can be doubt that va numbers of pupils give no more thought

ention to music after they leave school. is abandonment may arise from their having real love for music or from their having come prejudiced against it owing to its agreeable association with grinding pre-ratory work in school. I fear it must confessed that sounds and musical auty are too often things apart in a school. t it must often be the case that children p the study after school life because no ilities are afforded for continuing it. What uld be done for children in their teens er they have left school, is one of the avest and most difficult questions. We n only hope to solve it by the co-operation public spirited enthusiasts throughout the intry. Meantime those of us concerned in e schools will do our best for the children ile we have them under our care.

On the whole I think we can fairly claim be doing more for music in schools than y other country in the world. The steadi-ss and reality of the progress of the t ten years encourage us to hope for ich in the future. That future obviously pends mainly upon the musical skill and ching power of the coming generation of chers.

DISCUSSION.

Mr. W. DOBSON (Superintendent of Singing to the mingham School Board) said he had come from mingham to hear this paper, as this was a subject ich was broadening every day, would not only ect the elementary teacher, but, eventually, the ofessional musician; and by-and-bye he hoped the l school would be educated through the new. rhaps the most important point was the sight test combined time and tune, which would come into ce in April next. Tuneless time, and timeless ne were very unsatisfactory. A gentleman, on ing asked whether, in his opinion, boys and girls ould be educated together, said he thought the es should go together from the cradle to the grave; d so it was with regard to time and tune. They ist be united, and he was very glad to find that ose who had the ear of the Education Department d managed to secure that this should be recognised future. No doubt the time would come when the partment would require that all children in andard V. and upwards should be able to sing from e staff notation, because the moment they came in ntact with ordinary musical literature, they met h sharps and flats, crotchets and quavers, and it d been proved over and over again that those who d thoroughly learned the sol-fa system, were able sing from the staff notation after a short course of instruction. They know the things, and had only to learn a few new signs. They would then be able to help to educate the future musicians of the country. It was a singular fact that the teachers of the staff notation did not understand how to teach their own art. A hundred students from the Royal Academy would not teach class singing so well as a hundred school teachers trained in the sol-fa system.

Mr. A. L. COWLEY said he occupied the unenviable position of having to attempt an impossible task. He was supposed to superintend the instruction in singing of the whole of the 1,200 departments of the London School Board, with 474,000 scholars. Of course, it was quite impossible, but he did as much as he could. The subject had been put so clearly and logically in the paper, that there was not much more to be said, but he might express an opinion on one or two points. The question of specialists being employed to examine was a very large one; but with all the imperfections of the present system—and he could mention some very curious things which had occurred—the results spoke for themselves, and he thought it would be very unwise to make any alteration for the country as a whole. In many schools in large towns the singing was examined separately, on a different day to other subjects, and in such cases a special examiner could attend as well as the ordinary inspector; but that would only apply to large towns. The question of who should teach singing had also been touched upon; at present it was done by the regular staff, and when complaints were made that the results were not altogether satisfactory, indeed, in some cases, very unsatisfactory, it must be remembered that these teachers were not trained as musicians but as teachers, that they had to teach a great many things, and that music only occupied two half-hour lessons a week. But, even if it were not impossible, for financial reasons, to employ special teachers for singing, it would be unadvisable on other grounds. The ordinary staff were proportionate to the number of scholars, having 50 or 60 each; but a visiting teacher would have to come in, and take the whole school at one lesson, which would be far less satisfactory in large schools. One specialist could not do as much in the same time as six ordinary teachers. No other system, therefore, was feasible, and it only remained to make the regular staff as efficient as possible. Mr. McNaught had mentioned how largely the tonic sol-fa system was used. Under the London School Board, it was entirely optional; the teachers might employ any system they chose, and that had been so from the beginning. The result was, that at present there was one department out of 1,200 which taught the staff notation exclusively, a great number taught the tonic sol-fa exclusively, and a considerable number in the upper standards employed both. There he differed from his friend Mr. Dobson, and thought it should be left optional. In the London

School Board, there was one syllabus for the sol-fa, and another one for the staff notation; but the time might come when the latter might be added to the former, as an optional subject. It would be lamentable to disturb the work going on at present. With regard to the grant for singing by ear, he used to advocate its abolition; but as it was abolishing itself by degrees, he was quite content to let it go on, though the sooner it came to an end the better. He did not know whether it was possible to get anything more out of the Education Department, but he thought the ear singing grant would be abolished much more quickly if a higher grant were made for excellent results in note singing, such as had been shown that evening. When such a school only got the same amount as one which just managed to pass, it was not much encouragement. But if, instead of paying 1s. all round, 2s. were paid for high-class results it would encourage efficiency, and ear singing would be abolished sooner. He did not think £10 would be too much to pay for teaching 100 scholars as well as those in the Fleet-road School were taught. It was not pretended that they were paid for it, but while the system of payment by results continued, there should be something like adequate payment for excellence in singing, as in other subjects for which 2s. was paid. He was much interested in the after-results of this work, and when he thought how much of it was forgotten when the children left school, he was sometimes inclined to feel discouraged. But it was the same with other things; it was not confined to singing. Still, the more they could preserve what had been taught, and carry it on to higher achievements, the better for education all round. He hoped the time was not far distant when evening schools would develop into real continuation schools, so as to bridge over the interval between 13 years of age, and the time when the young people were ready to join choral societies, church choirs, and so on. There was a difficulty, of course, to boys at that particular age, but he expected that would be overcome, and if they could only manage it for the girls, that would be something. He did not think the teaching of singing was regarded as a drudgery they were glad to get rid of, but that, if opportunities were afforded them of continuing their studies, they would gladly take advantage of them.

Mr. ROTHERHAM said he need only refer to the regret which had been expressed that the after results of this teaching were so lamentably small, a point also touched upon by Mr. Cowley. It was to be regretted that the teaching of music in day schools was not regarded as being on a par with that of other subjects; but if by any means the taste and enthusiasm of the children in musical work could be increased, it would be of great advantage. Musical societies had it in their power in many ways to foster and encourage the enthusiasm for musical training, and it was in this direction that help should be looked for.

Mr. ROBERT F. VIRGOE said he was sorry to hea Mr. Dobson draw comparisons between the tonic so fa system and the teaching at the Royal Academy and he should like to know where he got his informa tion from.

Mr. DOBSON said he had seen it stated in a lectur or speech that the Tonic Sol-fa College was the onl institution which taught teachers how to teach, an where they had to give lessons. The result wa they were far before the Royal Academy students i teaching power, though the latter were supposed t be trained to teach the staff notation. His knowledg of staff notation teachers warranted him in sayin they were nowhere in teaching compared with sol-f teachers, whether professional or not. A non-pro fessional man, if he were a trained sol-faist, woul teach on true lines, which the other one did not.

Mr. R. E. THOMAS asked how far Mr. McNaugh would propose to carry the knowledge of the sta notation in connection with the sol-fa system?

Mr. R. ELLIOT BUTTON said the question of pitc seemed to be left out of consideration altogether i the sol-fa system. He believed that in the pieces th children present had to sing, there was a statement a the beginning that *doh* was *E* flat or *F*, but thoug the pupils could sing the music correctly he doubte if they had any idea of the pitch. One advantage o making the staff notation compulsory in the highe grade would be that it would necessitate some know ledge of pitch.

The CHAIRMAN, in proposing a vote of thanks t Mr. McNaught, said he much regretted that Sir Josep Barnby was not present to take the chair, because h could have made some practical remarks on the paper which he (the speaker) was not able to do, knowin nothing whatever about music. That reminded hin of the quotation from Mr. W. E. Forster, that th musical education of the upper and middle classe in England had been greatly neglected. It must b remembered, however, that in boys' schools, an musical work had to be done in spare time; it wa not part of the curriculum. It was said that Englis children were naturally musical, which confirmed a opinion he formed many years ago, when living i Italy. One heard a good deal about Italy bein a musical country; but when living there, i struck him that amongst young people the numbe of those who were musical was fewer than in thi country. It might be that the Italian air was goo for the voice, and many good singers were develope there, but he could not agree with the commo opinion that the Italians were more musical than th English. He had lived for some twenty years in th Celtic parts of Britain—in Cornwall and Wales— and he should like to know if Mr. McNaugh agreed with him in thinking that those peopl

ɜre more musical than the English. Welshmen, ɹrticularly, seemed thoroughly imbued with music, shown by the large concourse of all classes ɿich attended the Eisteddfodds. It was said at ear-singing was better than no singing, and he thought it was with regard to playing. In ungary one met with gipsy bands who played autifully, as it seemed to him, but they had no ɪtes, and he was told that they learned new pieces the conductor going to listen to an orchestra, ɪrning the piece by ear, and then teaching his nd in the same way. To his mind, singing lost a od deal of its charm if the words were not pro-rly pronounced. He thought there could be no doubt out the advantage of teachers being trained. ɛfore sitting down, he must, on behalf of all pre-ɪt, express his appreciation of the admirable ɪnner in which the choir of little girls from the eet-road School had illustrated Mr. McNaught's marks. The singing of these children reflected eat credit on the school and their traiuer, Mr. arris.

The vote of thanks having been carried unanimously,

Mr. McNaught, in reply, said that if the paper d the effect of drawing some little public attention the subject, he should be amply rewarded for his ɪuble. Mr. Cowley had spoken in favour of the ɡular school staff teaching singing in preference to ɛcialists, and he quite agreed with him. The ɛcialist system was in force in Scotland—in Aber-ɛn, Glasgow, Edinburgh, &c.; and having tested work done in those towns, and compared it with at was done in England, he did not find there s the slightest gain. On the other hand, there was considerable loss, because, while the singing son was going on, the teachers stood idly ɪking on, and they had no interest in the work, ɪ no incentive to study music themselves. In inburgh £1,300 a year was paid to the sic teachers, which was six times more than the ndon School Board gave to their Superintendent. ith regard to the Royal Academy, he was himself tudent there, and for four years he had been an ɪminer in sight singing, and three years ago he ɪmined every student individually. Neither at the ɪyal Academy nor at the Royal College was any empt made to teach the pupils how to teach; and ppeared, from the evidence of Sir Arthur Sullivan l Dr. Mackenzie before the Royal Commission on ucation, that they were rather opposed to it. They l you could not teach teachers to teach; that the of teaching was not to be taught; and at any the object in those institutions was to train sts, not teachers. A London School Board ɛher who knew only the scale would teach that ɛe much better than the finest R.A. student, ause he had method and science. With regard to degree in which the staff notation should be con-ɪed with the sol-fa, he thought he had better not attempt to answer the question, as it was now under the consideration of the Department. With regard to pitch, he should like to ask Mr. Button how many who learned the staff notation had any notion of it; his experience was that very few people possessed this faculty. At the Royal Academy, and elsewhere, he examined far more staff notation students than sol-faists, and very few had the sense of pitch. There were not more than 20 students in the Royal Academy who could tell the precise pitch of a note. Moreover, it was not necessary. Some of the finest singers, and even composers, had no exact notion of pitch, and it was no obstacle to progress. Music was a question of the relation of one sound to another, not of pitch. A tune was the same in whatever key it was pitched. For an orchestral conductor, and in certain other ways, it was a very useful gift, but it was not indis-pensable to a musician. At the same time, he was free to admit that sol-faists, as a rule, did neglect the study of pitch. With regard to the question put by the Chairman as to Cornishmen and Welshmen being more musical than the English, he should say they had great gifts of musical execution, particularly the Welsh, up to a certain point; they made splendid chorus singers of certain music, but they seemed to stop short at a certain point. They would not listen to a Beethoven symphony or quartette Their musical growth was vigorous, but stunted.

INDIAN SECTION.

On Thursday, 9th March, Mr. J. Athelstane Baines, I.C.S., read a paper on "Caste and Occupation at the last Census of India." Lord Reay, G.C.S.I., G.C.I.E., presided.

The paper and discussion will be printed in the next number of the *Journal*.

Miscellaneous.

COMMERCIAL MUSEUMS.

The *Journal de la Chambre de Constantinople*, in a report upon European Commercial Museums, says that Belgium holding such a prominent position in the economic history of Europe, it is not a matter of surprise to find this country being the first to estab-lish these institutions. At Brussels a museum was established with the special object of informing Belgian manufacturers and exporters as to the pro-gress of commercial affairs and the state of business in foreign countries, and of facilitating commercial transactions with importers and consumers. Antwerp possesses a commercial museum and a commercial

institute. Liege is also provided with a museum, which temporarily receives Government collections. The first commercial museum established in Europe was that of Melle, in Flanders; it is the property of a corporation, which has branches in all the countries of the world. There exists at Charleroi a museum, due to private initiative, as well as a permanent exhibition of the products of French industry, organised by the French Chamber of Commerce. The Netherlands owes also to private initiative its fine museum at Amsterdam. In the year 1884, a limited company established, in the centre of the city of Amsterdam, a commercial museum, which comprises an information bureau and a permanent exhibition. At Haarlem and Leyden, museums of colonial products also exist. Germany possesses the largest number of commercial museums, and her national products appear in all foreign museums. At each German Consulate a small museum and a commercial attaché are to be found. The idea of floating exhibitions, visiting the principal sea ports, has not hitherto, it is said, shown very satisfactory results. At Vienna and Buda-Pesth, the commercial museums are Government institutions, and these have wrought an almost complete transformation in the condition of Austro-Hungarian industry; in the Balkan countries exhibitions are organised and agencies established in different places. In Italy, in the museums of Milan and Turin, publications and data are to be found, which are useful alike to importers and exporters; these museums are established by the Chambers of Commerce and maintained by the Government. Zurich possesses a commercial museum subsidised by the Government. In Portugal there are museums at Lisbon and Oporto, which are in every way similar to the Belgian and German institutions. The Lisbon museum is situated at an hour's drive from the centre of the town; it is established in the old Belem convent, which is specially adapted for that purpose. It is a permanent exhibition, systematically organised, in which only Portuguese, Hungarian, and French houses are represented. France is beginning to realise the utility of commercial museums. The commercial museum of the Paris Bourse du Commerce, also due to private initiative, enjoys a high reputation; its object is to encourage and develop Parisian industries and to facilitate commercial transactions with foreign countries. Lyons possesses a museum of art and industry, and in the French colonies Tunis and Philippeville are already provided with commercial museums. Russia has commercial museums at St. Petersburg and Moscow, with branches in the East, and these institutions also exist in towns such as Belgrade and Cettinje. In Turkey, M. Alexandridi, Secretary-General of the Chamber of Commerce, Agriculture and Industry, at Constantinople, established in 1891, a store depôt of samples, with an information bureau, &c., which, owing to the assiduous efforts of its founder, has, it is said, made considerable progress since its recent installation in the Rue Findjadjilar at Stamboul.

WINE AND CYDER IN FRANCE AN[D] ALGERIA.

In 1892, according to the *Bulletin de Statistiqu[e et] de Législation Comparée*, which has just appea[red,] the yield of wine in France was estimated [at] 29,082,000 hectolitres (hectolitre is equivalent [to] 22 imperial gallons), and the area under vines [at] 1,783,000 hectares (hectare = 2·47 acres), that i[s, a] product of 16 hectolitres to the hectare. This agg[re]gate yield shows, as compared with the preced[ing] year, a diminution of 1,057,000 hectolitres, and, [as] compared with the average of the last ten years, [an] increase of 31,000 hectolitres. The yield of 1[892] was adversely affected by the frosts which occur[red] in April, and also, to some extent, by the prolon[ged] droughts of the summer. All the vineyards, ho[w]ever, did not suffer in the same degree; for examp[le,] the Gironde showed a falling off of 604,000 hec[to]litres, the Loire Inférieure of 581,000 hectolit[res,] and the Maine-et-Loire 566,000 hectolitres. On [the] other hand, there is an augmentation of 1,853,[000] hectolitres in Hérault, 590,000 in Pyrénées Orienta[les,] and 586,000 in Ande. These latter correspond [to] an increase of 20,000 hectares of productive vineya[rds] in Hérault, of 13,000 in the Ande, and of 3,[000] hectares in the Pyrénées Orientales. Taking [the] whole of the departments, there is an incre[ase] in twenty-eight and a diminution in forty-ei[ght.] According to the estimates made in each dep[art]ment based upon the various sale prices, [the] aggregate value of the yield amounted to 912,000,[000] francs (£36,480,000), that is, an average p[rice] of 31·40 francs per hectolitre, being 2·10 francs lo[wer] than the average price for 1891. This fall in pr[ice] may be explained by the fact that the spring fr[osts] particularly affected the production of the higher c[lass] wines; and this influence was particularly felt in [the] Gironde; in Indre-et-Loire, where the best qua[lity] vintages showed a falling off of 41,000 hectolit[res;] in the Côte d'Or and Yonne departments, w[hich] show a deficit of 16,000 hectolitres each; [and,] finally, in the Marne, which lost 13,000 hectoli[tres] of high-priced wines. There was an increased y[ield] of high-class wines in the Garde, Maine-et-Lo[ire,] Rhône, and Pyrénées Orientales, but the gain [was] not sufficient to counterbalance the loss experie[nced] in the other departments. The production of ra[isin] wine, which, from 4,293,000 hectolitres in 1[890,] fell to 1,704,000 hectolitres in 1891, again [fell] to 1,055,000 in 1892. In consequence of [the] increased tariff rates on the importation of d[ried] raisins, an increase which is not compensated by [the] modifications introduced into the internal dutie[s on] the manufacture, the industrial production of [wine] from raisins is only at the present time [of] trifling importance. In 1892, by reason of [the] unfavourable climatic conditions, the yield [of] wine in Algeria remained below that of [the] preceding year, the figures being 2,866,870 hec[to]litres in 1892, against 4,058,412 hectolitres in

1 . As regards the distribution of the produc- t in Algeria, 38,460 hectares in the department of ers were under vines, and produced 1,120,259 h olitres; in Oran, 48,478 hectares produced 1 3,681 hectolitres; and in Constantine the yield o 1,905 hectares amounted to 542,930 hectolitres. egards cyder, the yield in 1892 exceeded that of 1 by 5,861,000 hectolitres, and that of the average o he last ten years by 3,156,000 hectolitres, the a al figures for 1892 being 15,141,000 hectolitres. I ortant increases in the quantity produced have 1 noted in the Côtes-du-Nord, Eure, Ille-et- ine, Oise, aud Seine Inférieure. Finistere, Loire I rieure, La Manche, Morbihan, Orne, and Sarthe e been less favoured, while still showing a yield ier than the average of the last ten years. In vados, Maine-et-Loire, Mayenne, and the Pas-de- is the figures of the average decennial period e not been reached.

VENETIAN MOSAICS.

he British Vice-Consul at Venice says that the ndid mosaics now produced there continue to the first place in the artistic markets of the ld. Among the important works recently exe- d by the Venice and Murano Company, a well- wn mosaic manufactory, is a large mosaic panel resenting Columbus being received by Queen bella and King Ferdinand of Spain, after his rn from America. This panel, measuring about square feet, shows Columbus when kneeling ore the sovereigns, presenting to them the natives the newly discovered land, and some products of soil. The persons represented are about thirty- ht in number, many of them of the natural size, ned in three principal groups. In the most im- tant is Columbus having at his side the Crown nce, and the sovereigns surrounded by the digni- es of the Court, ladies and nobles, and pages ding the standards. In the middle group, but re to the left, are the native Indians, and near the rance of the hall other Spanish nobles, and the npanions of Columbus. The gorgeous and various ires of all the figures, their warlike implements, splendid stuffs of all sorts and tints, the rich oration of the hall, the pageantry of the Court, strange costumes of the natives in full contrast h the others, and the various attitudes of all these sonages, form a whole in perfect harmony with the tails of the scene, owing to the excellent distribu- n of the figures and the perfect fusion of tints. e work is so delicately executed, says the Vice- nsul, that no one can believe that the panel is not nted until on touching it he discovers that it is tirely composed of small enamel cubes, put gether without any aid of colour or cement, d worked according to the mode of the old Venetian mosaic school. This panel is to form the pendant of another, representing Columbus landing in America, and which will shortly be executed by the Venice and Murano Company. These mosaic works are executed for Mr. H. Furber, of Chicago, who is now building a palace near the Exhibition, which is to be called Columbus Palace, and will, it is said, be the largest in America. The two panels are to be placed in the entrance-hall. The author of the cartoons is Prof. Chev E. Paoletti, an artist well known in Venice, and affirmed to be one of the best painters who still maintain the traditions of the great Venetian school. As a work of art, the mosaic is said to be the most remarkable modern specimen ever exhibited.

THE PRODUCTION OF TIN IN THE MALAY PENINSULA.

The United States Consul at Singapore says that more than one-half the world's tin is mined in the Straits Settlements. The output for the year 1891 was 57,551 tons against 36,061 tons for the Straits Settlements. If to this 36,c61 be added the 12,106 tons, the output of the Netherlands India, whose tin-bearing islands are within a few hours steam of Singapore, it will leave but 9,384 tons for the rest of the world. Up to the introduction of modern tin-mining and smelting machinery in 1889, the tin was worked for a century in a most primitive fashion by the Malays. They simply dug down at the base of a hill, took up the clay which contained the *biji timah* (small nodules), and carefully washed it in running water. When dry, it was smelted in a furnace built of clay between two layers of charcoal, the fire being forced into a glow by means of bamboo bellows. When the metal became molten, it trickled through a hole in the bottom of the furnace into a vessel, from which it was ladled into moulds, forming slabs weighing about two catties ($2\frac{2}{3}$ lbs.). A rajah's or chief's wealth was reckoned in bars or slabs of tin. The primitive tin-mining of the Malays gave place to the more energetic and thrifty mining of the Chinese, who brought with them better tools and better business methods. The Chinese monopolised the entire field, until the formation of the Jelebu Company in 1889, with which the Chinaman can still compete. The Chinaman's manner of working is simple, though thorough. As the float-tin lies at a distance of from twenty to fifty feet from the surface, gradually diminishing towards the hill-sides, where it is not more than six feet, the jungle is cleared along its source, and water is brought by a ditch from the nearest stream. At about six feet down, the water begins to rise from the soil, and to get rid of this, and also to utilise the water from the stream as a motive power, an ingenious chain pump is made by constructing a long wooden

trough of three planks, each 100 feet in length, and this is placed with one end resting on the bank, the other sloping to the water in the lowest part of the mine. A wooden chain, with its small oblong pieces of wood, placed at right angles to the line, is fitted accurately into the trough. The wooden chain is endless, and is passed round two wheels, a small one at the lower end of the trough, and a large one at the upper end. The latter is a water-wheel, and is turned by a constant stream of flowing water. Round the axle of this wheel are cogs, each of which, in turn, as the wheel revolves, draws up a link of the endless chain through the trough, and, as each joint fits accurately into the trough, they bring up in succession a quantity of water, which on reaching the mouth of the trough falls into the channel by which the water which turns the wheel is carried off, and is thus also taken away out of the mine and conducted to the next, when the process is repeated. The small wheel at the lower end of the trough regulates the chain, and guides the wooden joints into the trough. The Chinaman's tools consist of a hoe, two baskets, and a bamboo pole. The soil is scraped with the hoe into the baskets, which in turn are balanced over his shoulders at the ends of the bamboo pole. The washing is performed in much the same way as placer gold is washed in California and the West. The soil is thrown into a trough filled with running water, in which the dust is carried off in solution, and the ore retained by means of wooden bars nailed across the bottom of the trough. While the Chinese system of smelting is similar to that of the Malays, it is more elaborate, and carried out on a much larger scale. In place of the bamboo bellows, a very ingenious plan is adopted. The trunk of a tree, about eighteen inches in diameter and ten feet long, is carefully hollowed out, and closed at either end. A long pole, with a circular piece of wood at one end fitting exactly into the bore of the tube, acts as a piston. In order to secure the tube being perfectly air-tight, the end of the piston is well padded. Valves are placed at each end, to allow the air to enter, and the centre of the nozzle of the bellows communicates with the furnace by means of a small air-passage. On the piston being drawn out, the air in the higher portion of the tube is forced down the nozzle, and being drawn back, the air in the further part of the tube is similarly drawn into the furnace. The charcoal is soon brought to a white heat, and ready for the moulds. The best of the Chinese mines are found in Laroot, in the northern part of Perak, south of the Siamese State of Quebrada, in a stratum of whitish clay. In some of the tin mines in the neighbourhood of the Batang and Padang rivers, small quantities of gold are found mixed with tin. Consul Wildman says that the Jelebu Tin Mining and Trading Company is the only successful European-managed mining adventure in Malaya, and one of the chief producers of Straits tin.

Correspondence.

TELE-PHOTOGRAPHY.

I find that I have omitted in the printed matt of my paper to call attention to the fact whi I mentioned at the meeting on the 1st inst., that t specially-constructed tele-photographic lens, ill strated in Fig. 5 with an unsymmetrical negati has the property of giving a perfectly flat field f *two* separate extensions of camera. When t camera is only moderately extended, the negati illustrated in this figure takes the reversed positio but when considerably extended, it should be plac as illustrated in the figure referred to.

With a shortened positive and a symmetric negative, as illustrated in Fig. 4, there is *one* positic in which a flat field is attained; if the extensic is shorter than this, the field is concave towar the lens, but if a greater extension be given f the plane of the image, the image has a tenden to be convex towards the lens.

In Fig. 5 there are two such planes of perfe flatness, which is a considerable advantage for lens constructed only for parallel rays. For gener work, however, the combination illustrated in Fig. which may be made aplanatic for various extensio of camera, and *for various distances of the obje focussed for*, is preferably recommended as the be system.

THOMAS R. DALLMEYER.

25, Newman-street, London, W.,
March 7th, 1893.

In your report—for the most part remarkab accurate—of my part in the discussion on M Dallmeyer's paper, I am represented as claiming t have originated the flattening of the field of the tel photographic lens. This I certainly did not inter to do. It was, in fact, in replying to a letter, i which Mr. Dallmeyer informed me that he had su ceeded in flattening that field, that I mentioned th method, and a particular form of positive lens th seemed to me best fitted for that purpose.

Mr. Dallmeyer did say that I was the first to poi out the reversed curvature of the field of the tel photo lens, and, I think, implied that it was in conse quence of my observation that he set to work to g rid of it. I may have referred to this when speak ing, and so, in condensation, it came out as print.

W. E. DEBENHAM.

General Notes.

ELECTRIC LIGHTING IN PARIS.—According t the *International Bulletin of Electricity*, of 85,00 houses in Paris, 20,000 are lit by electricity. Th

ıal capacity of the central stations is said to be ooo horse-power, and the number of lights, ,000.

Cotton Manufactures in Japan.—Although Japanese now manufacture cotton largely, their ports of European and Indian cotton manufac-:s have averaged, in the past three years, nearly 000,000 sterling in value.

Matches.—The import of matches from Europe become an important item of Chinese trade; quantity received being 3,378,284 gross in 1889, 6,895 gross in 1890, and 4,894,611 gross in 1; the estimated value in the last year being over 0,000.

Eastern Raw Silk.—The value of the exports Japan raw silk, which had gone on steadily in-ısing in the last 14 years, rising from £1,375,000 1877, to £3,900,000 in 1889, have began again to line, falling to half the value in 1890, a decrease £1,837,000 on the previous year. China, on the ıtrary, has gone on increasing her exports of raw s to over 106,000 cwt. in 1891, besides 78,529 cwt. refuse silk, and 21,303 cwt. of wild silk and oons. The waste and wild silk being now an im-tant element for the silk manufacturers of Europe.

Cotton Mills in India.—There were 127 ton mills at work last year in India, containing 670 looms and 3,272,988 spindles. They em-yed a daily average number of 117,922 persons whom, as far as details had been obtained, re were 681,330 men, 24,114 women, 15,960 young sons, and 8,418 children. The industry dates m 1851, when the first mill was started. Of the 7 mills, there are 87 in the Bombay Presidency, of ich 65 are in the town of Bombay. There are nills in Bengal, all in the vicinity of Calcutta; 10 Madras, of which 4 are in the town of Madras, in the North-West Provinces, and the others ttered over different districts.

Paris Theatres in 1892.—According to a report the last number of the *Bulletin de Statistique de la gislation Comparée*, the gross receipts of the ncipal places of entertainment in Paris, in 1892, ounted to £901,332, as compared with £943,986, 1891, and £920,536, in 1890. In the exhibition ırs of 1867, 1878, and 1889 the amounts were 79,354, £1,226,299, and £1,285,559 respectively. ıring last year the largest amount realised by any the places of entertainment in Paris was £126,250, cen at the Opera-house; the next in importance s the Comédie Française, with £77,454; and after came the Opéra Comique, with £68,090; the ppodrome, with £54,831; the Vaudeville, with 4,070; and the Théatre du Châtelet, with 6,741. At the Nouveau Cirque, £33,832 were cen; at the Cirque Franconi, £21,151; and at the lies Bergères, £32,708.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock:—

March 15.—"Technical Education: its Progress and Prospects." By Sir Philip Magnus.

March 22.—"The Manufacture of Non-poisonous White Lead." By Percy F. Nursey, C.E.

The reading of the paper on "Photographic Perspective," announced for this evening, has been postponed, in consequence of the illness of Mr. Van der Weyde.

Papers for meetings after Easter:—

"Transatlantic Steamships." By Prof. Francis Elgar, LL.D.

"The Construction of Locks and Safes." By Harry W. Chubb.

"Some Economic Points in connection with Electricity Supply." By Gisbert Kapp.

"The Optical Correction of Photographic Perspective." By H. Van der Weyde.

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

April 6.—Sir Edward N. Coventry Braddon, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisation." The Lord Brassey, K.C.B., will preside.

April 27.—Sir Juland Danvers, K.C.S.I., "Indian Manufactures: their Present State and Prospects." Sir Alexander Wilson, formerly President of the Bengal Chamber of Commerce, will preside.

May 18.—Sir Raymond West, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results."

Foreign and Colonial Section.

Tuesday evenings at Eight o'clock:—

March 21.—Cecil Fane, "Newfoundland." Sir Charles Tupper, Bart., G.C.M.G., will preside.

April 18.—H. A. McPherson, "The Philippine Islands."

May 2.—E. Delmar Morgan, "Russian Industrial Art."

May 18.—W. B. Percival, Agent-General for New Zealand, "New Zealand."

Applied Art Section.

Tuesday evenings, at Eight o'clock:—

April 11.—Prof. Paul Schulze, "History and Development of Pattern Designing in Textiles." Thomas Wardle will preside.

May 9.—Prof. W. M. Flinders Petrie, "Primitive Art in Egypt." Edward J. Poynter, R.A., will preside.

MAY 30.—JAMES DALLAS, "Devonshire Pottery."

*** The meeting originally announced for March 14 will not be held, but will be replaced by an additional meeting in May.

CANTOR LECTURES.

Monday afternoons, at Five o'clock:—

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Three Lectures.

LECTURE II. — MARCH 13. — Advances in our knowledge of Alloys, since the last course of Cantor Lectures "On Alloys" was delivered in 1888.

LECTURE III. — MARCH 20. — Applications of Alloys in Metal Work, with special reference to the Art Collections in the South Kensington Museum.

LEWIS FOREMAN DAY, "Some Masters of Ornament." Four Lectures.

April 10, 17, 24; May 1.

C. HARRISON TOWNSEND, F.R.I.B.A., "The History and Practice of Mosaics." Two Lectures.

May 8, 15.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 13... SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Cantor Lectures.) Prof. W. Chandler Roberts-Austen, "Alloys." (Lecture II.)

Geographical, University of London, Burlington-gardens, W., $8\frac{1}{2}$ p.m.

British Architects, 9, Conduit-street, W., 8 p.m.

Medical, 11, Chandos-street, W., $8\frac{1}{2}$ p.m.

TUESDAY, MARCH 14...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Victor Horsley, "Physical and Psychical Neurology."

Sanitary Institute, 74A, Margaret-street, W., 3 p.m. Dr. A. T. Schofield, "Some Recent Sanitary Reforms and Revolutions." 8 p.m. Dr. J. F. Sykes, "Objects and Methods of Inspection."

Medical and Chirurgical, 20, Hanover-square, W., $8\frac{1}{2}$ p.m.

Civil Engineers, 25, Great George-st., S.W., 8 p.m.

Asiatic, 22, Albemarle-street, W. 4 p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Mr. G. H. Emerson, "Naturalistic Photography."

Zoological, 3, Hanover-square, W., $8\frac{1}{2}$ p.m. 1. Mr. Oldfield Thomas, "Suggestions for the more definite Use of the Word 'Type' and its Compounds. as denoting Specimens of a greater or less degreee of Authenticity." 2. Mr. A. D. Michael, "A New Genus and Species of *Acarus* found in Cornwall." 3. Mr. P. L. Sclater, "A new African Monkey, with a List of the described Species of *Cercopithecus*." 4. Prof. Howes, "The Variation and Development of the Vertebral and Limb-skeletons of the Amphibia."

Colonial Inst., Whitehall Rooms, Hôtel Métrop, Whitehall-place, S.W., 8 p.m., Dr. George Dawson, "The Mineral Wealth of Bri Columbia."

WEDNESDAY, MARCH 15...SOCIETY OF ARTS, John-str, Adelphi, W.C., 8 p.m. Sir Philip Mag, "Technical Education: its Progress and P pects."

Meteorological, 25, Great George-street, S. Mr. Shelford Bidwell, "Some Meteorolog Problems."

Microscopical, 20, Hanover-square, W., 8 p.m. Dr. G. M. Giles, "Cystic Worms simulating appearance of Tuberculosis." 2. Dr. A. Sto "New Brackish-water Infusoria from the Un States." 3. Surgeon V. G. Thorpe, "Rotifera China."

Archæological Association, 32, Sackville-street, 8 p.m.

Inventors' Institute, 27, Chancery-lane, W.C. p.m.

THURSDAY, MARCH 16...Royal, Burlington-house, W., $4\frac{1}{2}$ p

Antiquaries, Burlington-house, W., $8\frac{1}{2}$ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. G. F. Scott-Elliot, "Botanical Results of Sierra Leone Boundary Commission." 2. Mr. J. Pocock, "Contributions to the Arthroped Fa of the West Indies."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. K. Rose, "Limits of Accuracy of Gold-bull Assay and the Losses of Gold Incidental to i 2. Profs. W. Ramsay and John Shields, "Boil Point of Liquid Nitrous Oxide at Atmosphe Pressure, and on the Melting Point of Solid Nitr Oxide." 3. Messrs. W. R. Dunstan and Dymond, "Isomerism of Aliphalic Aldoxime 4. Mr. W. R. Dunstan, "Formic Aldoxime." Messrs. W. R. Dunstan and M. C. Luxmc "Properties of a Benzaldoxime."

Royal Institution, Albemarle-street, W., 3 p Rev. Augustus Jessopp, "The Great Revival Study in Mediæval History."

Historical, 20, Hanover-square, W., $8\frac{1}{2}$ p.m. Emil Reich, "The Magyar County: a Study the Comparative History of Municipal Insti tions."

Numismatic, 22, Albemarle-street, W., 7 p.m.

Camera Club, Charing-cross-road, W.C., 8 p Mr. L. Warnerke, "The Development of Printi out Papers."

FRIDAY, MARCH 17...United Service Institute, Whiteh yard, 3 p.m. Colonel T. S. Cave, "Volunt Transport."

Royal Institution, Albemarle-street, W., 6 p Weekly Meeting, 9 p.m. Dr. W. J. Russ "Ancient Egyptian Pigments."

Sanitary Institute, 74A, Margaret-street, W., 3 p Dr. A. T. Schofield, "The Hygiene of Nerves, Brain Hygiene with reference to Over-pressure Girls' School Life." 8 p.m. Dr. A. Newsholn "Nature of Nuisances, including Nuisances t abatement of which is difficult."

Quekett Microscopical Club, 20, Hanover-squa W.C., 8 p.m.

SATURDAY, MARCH 18...Royal Institution, Albemarle-stre W., 3 p.m. Lord Rayleigh, "Sound and Vibr tion."

The Telegraphic Address of the Society of Ar and of the Royal Commission for the Chica Exhibition, is "Praxiteles, London."

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FRIDAY, MARCH 17, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday afternoon, March 13th, Prof. W. Chandler Roberts-Austen, C.B., F.R.S., delivered the second lecture of his course on "Alloys."

Professor Roberts-Austen will deliver a fourth lecture on Monday, March 27th.

The lectures will be printed in the *Journal* during the summer recess.

INDIAN SECTION.

The paper of Mr. J. Athelstane Baines, C.S., on "Caste and Occupation at the last Census of India," and the discussion thereon, will be printed in the *Journal* of March 31st.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1893 early in May next, and they, therefore, invite members of the Society to forward to the Secretary, on or before the 15th of April, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit for promoting Arts, Manufactures, or Commerce," and has been awarded as follows in previous years:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole K.C.B.

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., late Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (now Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (now Lord Kelvin), LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (now Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (now Lord Masham).

In 1887, to Her Majesty the Queen.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S.

In 1892, to Thomas Alva Edison.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Tuesday, 14th March. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Birkbeck, Bart., Sir Edward Braddon, K.C.M.G., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Michael Carteighe, R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, Lord Alfred S. Churchill, Professor James Dewar, M.A.,

LL.D., F.R.S., Major-Gen. J. F. D. Donnelly, C.B., Sir Henry Doulton, James Dredge, Prof. Clement Le Neve Foster, D.Sc., F.R.S., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Walter H. Harris, Charles Malcolm Kennedy, C.B., John O'Connor, B.L., Wyndham S. Portal, William Henry Preece, F.R.S., Prof. Wm. Chandler Roberts-Austen, C.B., F.R.S., and Sir Owen Roberts, M.A., D.C.L., F.S.A.

Proceedings of the Society.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 15, 1893; HERBERT C. SAUNDERS, Q.C., Chairman of the Executive Committee of the City and Guilds of London Institute for the Advancement of Technical Education, in the chair.

The following candidates were proposed for election as members of the Society:—

Chatterton, Alfred, College of Engineering, Madras.
Knight, Edgar William, Junior Athenæum Club, W.
Schiller, Frederick William, 205, Brixton-road, S.W.
Simmonds, T. C., Burton-road, Derby.

The following candidates were balloted for and duly elected members of the Society:—

Adam, Sir Frank Forbes, C.I.E., Alderley-edge, Cheshire.
Bhagranani, M. S., B.A., Khairpur, Sindh, India.
Bristow, John Griffin, M.A., 1, Copthall-buildings, E.C.
McCoy, M. P., 54, Farringdon-road, E.C.
O'Driscoll, Florence, M.P., 18, Gower-street, W.C.

The paper read was—

TECHNICAL EDUCATION: ITS PROGRESS AND PROSPECTS.

By SIR PHILIP MAGNUS.

Ten years have elapsed since I gave an address on the subject of Technical Education in this room. Since then, much has been written on the subject, and I should have thought that the last useful word had been spoken; but the Council of this Society have thought differently, and in answer to their invitation, I am here to-night to report progress, and to indicate, as best I can, the directions in which further action is needed.

EARLY PROGRESS.

In February, 1883, the Finsbury Technical College was formally opened, and it is not claiming too much for that institution to say that the scheme of education and the methods of instruction, which were then somewhat new, have since been followed, with more or less success, in other similar institutions. What that college had at starting, other colleges are only now gradually acquiring—sufficiency of funds. The Finsbury Technical College owes its success to several causes—to a carefully prepared scheme of education which is still in operation, to the services of competent, original-minded and enthusiastic teachers, to absolute freedom from the trammels of State grants, and to a well devised and adequate equipment. Possibly we may find in these facts suggestions for the further advance of technical instruction.

In the following year the Central Institution was opened, and the strictness of the entrance examination enabled the Professors to raise somewhat the standard of higher technical instruction in this country; and, although at first the number of students was small, the reputation which the college has now acquired makes admission to its courses a prize eagerly sought by pupils of some of our best secondary schools. In the same year the Report of the Royal Commission on Technical Instruction was published; and since then numerous individuals and deputations have visited the Continent with a view of seeing for themselves what the Commissioners described, and o[f] verifying their conclusions. The report of the Commissioners, although nine years old, is still regarded as a trustworthy book of reference for information on foreign schools, and its statements and recommendations have largely helped to shape the efforts which have been made to promote technical education in this country. It must not be supposed, however, that in the matter of education Continental nations have, during the last nine years, remained stationary. Their progress has been, in many directions, very marked and considerable additions are needed t[o] bring the Commissioners' Report of 1884 u[p] to date.

LEGISLATIVE ACTION.

Although voluntary efforts, on a large scale were made during the few years following th[e] publication of this report to establish technica[l] schools and to promote technical educatio[n] there was no great progress, owing to the wan[t] of the necessary funds; and it was not ti[ll] 1889, when the Technical Education Act wa[s] passed, and local authorities were empowere[d]

impose a rate for the provision of funds, at the people of this country became alive to eir responsibilities. It is difficult, however, say how long they might have borne the ight of their responsibilities without being oved to action if that measure had not been llowed by the Local Taxation Act, which at ice placed at the disposal of County Councils ore funds than they, at the time, knew how sely to expend.

The newly-appointed local authorities ddenly and unexpectedly found themselves ustees for the public of large funds, to be pended for the promotion of education, in nnection with the industries and commerce of this country. The majority of the embers of these councils, whilst honestly sirous of utilising these funds for the purpose for which they were intended, were eatly in need of guidance, and the appointent of Technical Instruction Committees, and organising secretaries, charged, in the first ace, with the duty of instituting inquiries, as a wise and useful course, which was enerally adopted. The members of these mmittees themselves felt the necessity of me information as to the meaning and ethods of technical education, and the pply of such information was undertaken, ith, I venture to think, great success, by e National Association for the Promotion of echnical Education. It was very important at those who were suddenly and unexpectedly trusted with the spending of large sums of oney should have some idea of the character the work they were undertaking; and if, as fear, some of this money has not been as sefully expended as it might have been, due lowance must be made for the inexperience those on whom so heavy a responsibility ad fallen. A revolution in our education— r the demand for technical instruction is fecting a revolution in the theory of popular lucation—is not readily accomplished; and I ink the country is to be congratulated on the artial success which has attended the changes at have been made. The problems to be lved are by no means easy; and it cannot be pected that progress will be made without me mistakes.

One result of the discussions which have ken place is that the public begin to see at technical education is not an altogether w and separate kind of training, but that it closely connected with, and, indeed, enters to, as an essential part of, elementary, condary, and higher education. To have established this fact is to have cleared th ground of many errors, and to have prepared the way for the future better organisation of each of these grades of instruction. The clear comprehension that technical education is not something altogether distinct from the general teaching given in schools and colleges and evening classes is very important in helping to co-ordinate the different institutions which are now concerned with the direction of various departments of education.

Voluntary Effort—City Guilds Institute.

The past decade may be considered in the history of technical education as the period of voluntary effort, which so often precedes that of State action in this country. Foremost among the voluntary agencies which have been preparing the way for State action has been the City and Guilds of London Institute. The Central Institution at South Kensington, of which I have already spoken, is, perhaps, already the chief engineering college in the country, and nothing is wanting to bring our technical instruction to the level reached in Germany and Switzerland, except the better preparation of those who have to pursue their studies on the technical side of the university. The Finsbury College has indicated the kind of instruction which institutions for artisans should aim at affording. It is now, as it was when first started, unique in its aim and organisation. Other institutions are approaching it very closely; and there is reason to hope that, with the funds now available for the purpose, the technical teaching of artisans is likely to be greatly improved. But, possibly, the widest reaching organisation for the encouragement of technical instruction among artisans has been the Institute's system of technological examinations. The great feature of this scheme has been its suggestiveness in indicating courses of instruction for the guidance of local bodies, adapted to a large number of the trades and industries carried on in different parts of the country. Before any public funds were available for technical and trade teaching, the grants made by the City Guilds Institute on the results of its examinations afforded considerable encouragement to the formation of technical classes, which have since developed into technical schools. Figures showing the numbers of students in attendance at these classes cannot be taken as a very sure or trustworthy indication of the success of the

movement, but they serve to give a general idea of progress, and of the greater interest which artisans and their employers now show in this branch of education. Taking these figures for the last ten years, we find that in 1883 there were 4,052 students in attendance at 154 centres, and in 1893, 22,512 students at 284 centres; whilst in 1882, there were 2,397 candidates for examination, and in 1892 this number had increased to 8,443.

Science and Technology.

These numbers would probably be much larger but for the greater encouragement afforded by the Science and Art Department, through the grants on results, to attendance at classes in subjects in many respects similar to those included in the programme of the City Guilds' Institute. Although not called so, the Department has for many years been a department of technical instruction. In its School of Mines, and in many of its subjects of examination, we have indications of the technical character of its work; and year by year, with the growing demand, the tendency has been for its work to become more technical. It has been difficult to avoid, therefore, a certain amount of overlapping in the examinations of these two departments, notwithstanding the efforts that are made on both sides to maintain a distinction between their respective functions. For example, much of the instruction which is given in the building construction classes of the Department is also given in the carpentry, brickwork, and plumbing classes connected with the Institute. Most of the students attending a class in building construction are engaged in one or other of those separate branches of trade; and there is very little doubt that the teaching given in specialised classes connected with the Institute is better adapted to the requirements of these artisan students than that given in the wider subject, for which grants on results are paid by the State. So, too, in the technical subject of mechanical engineering, much of the teaching given in the Institute's classes is covered by the instruction in applied mechanics, machine drawing, and steam, which are regarded as science subjects in the directory of the Department. The teaching which the Institute's examinations encourage is essentially practical, and directly connected with the students' occupations; and it is possible that, if some other system were adopted for distributing State aid than payment on results, the more specialised instruction in connection with the Institute examinations would be more general, and th present overlapping of teaching would b avoided. In the majority of subjects th spheres of action of the Institute and of th Department are sufficiently distinct. Subject such as botany and zoology, on the one han and weaving and watchmaking on the othe lie at the two ends of a series of scienc and technical subjects. But midway in th series are subjects relating to building an machine construction, in which the distinctio cannot be so easily drawn; and if in thes subjects the payment by means of grants o results were suspended, and the equivalen State aid were given on some other system the students would be freer in their choic of classes, and would probably select those i which the instruction has a closer connectio with the trades in which they are several engaged.

Theory and Practice.

Apart altogether from this question of organi sation, there is a difficulty in determining th exact relations to be maintained betwee theory and practice in evening technic classes. It is generally agreed that technic education should supplement, and not tak the place of, workshop training. Unless w accept this principle, our technical class would become apprenticeship schools, an the training would occupy much longer tim and would needs be very different in kind But there are two directions in which th technical class has to substitute the worksho These are—(1) in providing instruction in th scientific principles underlying the explanatio of processes; (2) in practising the student i other branches of his trade than the or section with which, owing to the extreme su division of labour, he is almost exclusive occupied in the shop. Now, there is n always complete accord among those co cerned in the importance attached to th technical teaching to be given on thes somewhat distinct lines. There can be n doubt of the value of each kind of instru tion, but the one is more educational tha the other; the one supplements the worl shop practice, by training the mind of th student, so as to make the worker more in telligent and generally more capable; th other by extending the student's practic acquaintance with his trade. Of course, th necessity for both is due to the condition under which industrial operations are now co

ucted. But it often happens that the artisan keener to supplement his workshop practice one direction than in the other, and attaches ore value to extended practical skill than to e intellectual training to be obtained from study of the application of science to his ork; whilst, on the other hand, it is somemes found that artisans take the narrowest ew of their work, and attach little interest to e connection between the different sections to which the practice of their trade may be vided. Now, I refer to these matters as dicating the difficulty of some of the problems hich have to be considered, and to show the nportance in devising schemes of technical istruction of carefully studying such questions their commercial and educational aspects.

Recognised Principles.

Whilst difficulties arise in determining with espect to different trades, the relation etween theoretical and practical teaching, ie experience of the last ten years has shown ie importance of recognising the following eneral principles in regulating technical lasses:—

1. All trade teaching should be associated ith drawing, or should have reference to the rinciples of science underlying it; in other ords, it should rest on a basis of theory.

2. The teaching should be illustrated by eference to the instruments used in the trade. Ience the necessity of apparatus, and tools, nd of laboratory and workshop appliances.

3. The instruction must be wider than the ection of the trade in which the student is ngaged. It must help to correct the crampng influence, and must not too closely follow he course, of the division of labour.

4. The teaching should be primarily adapted o the requirements of students engaged in he actual practice of the trade, and not to mateurs.

Now, I am glad to see that Mr. Llewellyn mith, who has devoted much time to the onsideration of the problem of technical nstruction, is in general agreement with me s regards these four fundamental principles. In his very able report to the London County Council he says:—"Workshop instruction, vhere aided, must always be associated with heoretical teaching or drawing." This prinipleshould be maintained. In handicrafts nvolving design, drawing, and, in certain ases, modelling should be taught, and in rades involving the application of mathenatical or physical science, the workshop practice should be associated with efficient instruction in the theory of the subject. If this condition of giving grants is enforced, the County Council will not only help to provide the means for, but will also aid in improving, technical teaching.

The second principle is no less important—that technical classes should be provided with sufficient models, tools, and other apparatus.

Hitherto, the poverty of the schools has prevented this provision from being made; but now that funds are available, it is desirable that our technical classes shall possess the practical appliances for the explanation of processes, for illustrating the scientific principles involved, and for supplementing, as I have already indicated, sectional shop-practice.

As regards the application of the third principle great caution is needed. The sectional divisions of the trade are now so complete, that they may be regarded as separate industries, and the workmen engaged in one division are often wholly ignorant of the work in other divisions. Now, in arranging courses of instruction, a very large amount of freedom and spontaneity must be left to local bodies, familiar with the requirements of particular districts. At the same time, some external directive influence is desirable to prevent the teaching from becoming so narrowed as to be no longer educational, and to be of temporary and local value only to the artisan. Whilst great help and guidance can be obtained from manufacturers, teachers, and trade experts, without which the organisation of technical classes would be impossible, some external direction is necessary to secure teaching of such a kind as shall train the intelligence of the student, and give him a broad and serviceable knowledge of his work.

As regards the fourth principle, it is, I think, most important that, unless our trades are to suffer, access to a trade should not be attempted through evening technical instruction only, as a substitute for apprenticeship, or for systematic and lengthened workshop practice. The modern apprenticeship is a combination of workshop practice and class instruction; but neither alone, and certainly not the latter, affords adequate preparation for admission to a trade. For this reason, in many subjects, it should be a condition of entrance to a trade class that the student is engaged in the practice of the trade to which the teaching directly applies. Here, again, I am glad to find Mr. Ll. Smith has given the

London Council good advice. He says :—" If your technical classes undertook, like those of Paris, to teach a trade, of course people outside a trade would be admitted; but, as they merely try to *supplément* workshop teaching —the school workshops being mainly illustrative—they can only discharge their proper functions usefully for students actually engaged in the trade at the time." As regards the Paris classes, to which he refers, it should be understood that they are day schools, in which the pupil is engaged during the greater part of the day in practical exercises.

London Polytechnics.

In connection with evening technical instruction, I must refer to those unique institutions which have recently been established in London, and are still in process of formation, and are known as Polytechnic Institutions. These institutions are a product of the last ten years. The first to be established was the Regent-street Polytechnic, which was followed by the People's Palace; and whilst the Charity Commissioners were considering a scheme for planting in each district of London a similar institution, the Goldsmiths' Company took upon themselves the burden of the support of the New-cross Institute; and since then the Borough-road Polytechnic, the first established under the scheme, has come into active operation. These institutions have two very distinct objects, the one is to afford healthful recreation and amusement to the working classes; the other is to improve their technical knowledge and skill, and generally to provide continuation schools for the artisan classes. There does not at first sight seem any special reason for the combination of these two functions in the same institution; and the experience gained is not yet sufficient to enable any authoritative opinion to be expressed with regard to the success of the combination. Of the necessity for the establishment of institutions which shall serve the purpose of workmen's clubs, and shall be the means of elevating the tastes of the artisan classes, and of affording, in the poorest districts, centres of healthful recreation, there can be no possible doubt. It does not appear, however, that any sufficient reason has been shown for associating with such recreative institutions, classes, laboratories and workshops for technical instruction. Certainly, in the provinces, where large technical schools have already been established, and where they are undoubtedly doing excellent work in connection with the manufactures and trade of the district, no such alliance of amusemen and instruction has been attempted; and it i open to question whether the atmosphere c club life, in which the technical schools c London are being reared, will prove conduciv to that serious study which is as indispensabl for the technical instruction of artisans as i the education of any other class of person If the Technical Classes in connection wit the Polytechnic Institutions are to benef London industries, and to be seriously con ducted with the view of educating our artisans and of improving the trades in which they ar engaged, it is quite certain that the tw functions of a London polytechnic must b kept carefully distinct. This has been don to some extent in the case of the Borough-roa Polytechnic; but whilst class instruction an social amusement are simultaneously con ducted, and are carried on in neighbourin room, it is difficult to secure regular attend ance, and to prevent the attention of th students from being distracted from their work The appointment of a Director of Studies, t superintend the educational division, is a usefu step; but it may become necessary to d more, and to assign separate evenings fo work and play. At present, these institution are in their early infancy, and mistakes hav been made, some of which have been cor rected; but, having regard to the large sum of money which have been subscribed by th public, and to the funds which have bee devoted by the Charity Commissioners, and t the further grants which are about to be give by the County Council to these institutions it is important that the educational work, fo which the grants of the County Council ar alone available, shall not be neglected.

To complete the scheme of instruction i these polytechnics, it is desirable that th central authorities contributing the fund should appoint inspectors to report on th character of the teaching, to ascertain tha the schools are provided with a sufficiency c suitable apparatus, and that a proper relatio is maintained between the theoretical an practical work, and to confer with the principa and teachers with respect to the arrangemen of systematic courses of instruction. In thi direction some progress is to be looked for.

It is quite certain that the success of thes institutions must not be judged merely by th number of members on the books, nor eve by the number of entries on the class registers As regards the technical classes which ar

carried on in these institutions, and from which they derive their name, it is desirable that these should not remain separate grant-earning classes, but should be so organised as to become schools for trade instruction, so that each student may find, in connection with his own work, a properly co-ordinated and progressive course of instruction. It must not be supposed that this state of advancement has yet been reached. It is also important that these trade schools should be arranged with strict reference to the principal trades practised in the district, and that certain subjects requiring special appliances, such as electrical engineering, should not be taught in every institution, but preferably at a few well-equipped centres provided with sufficient apparatus.

Preparatory Instruction.

I have said that the students of the trade classes should be persons engaged in the trade with which the teaching is associated, but it is equally important that they should be sufficiently advanced in general education to follow and profit by the instruction. To test the fitness of artisan students to receive instruction in technological or trade classes, I look forward to the time when they will be required to pass an examination before entering such classes. Most technical schools provide instruction in such subjects as arithmetic, elementary geometry, drawing, and the rudiments of science; and efforts should be made to induce apprentices, and other young people whose school education is defective, to attend preliminary classes in such subjects before entering upon their strictly technological courses. Such instruction might be so arranged that the exercises and illustrative examples would be selected from subjects with which the student is familiar in his workshop practice; but it is important, in this grade of teaching, as in higher grades, that the technical instructor's time should not be spent in teaching those elementary subjects, a knowledge of which a boy should bring with him from school.

Similarly, the degree of practical skill previously acquired by the young apprentice in the commercial workshop might also be tested prior to his being admitted to a strictly technical class; and such a test would be a means of preventing persons in no way connected with the craft, or with insufficient knowledge of it from entering a class and impeding the progress of the other students. If these preliminary tests were applied, the number in attendance in our technical classes might be at first reduced. But the success of the school is not to be judged so much by the number of its students as by the quality of their work; and experience has shown that entrance examinations have the effect not only of bringing in more earnest and capable students, but, in the end, of increasing the number of those who are able to receive advanced instruction.

Junior Classes.

To enable the younger and imperfectly prepared students to qualify for entrance into the technological classes, junior classes might be held at the Polytechnic and other technical institutes. If students who were unable to pass the entrance examination were required to attend these junior classes, the consequent improvement in the strictly technical teaching would be very marked. The instruction in these junior classes would include what is commonly called technical arithmetic, drawing to scale, and elementary notions of physics, and practice in the use of some of the instruments commonly employed in accurate measurements. Such preliminary courses would by no means take the place of the more systematic study of different branches of science which is required by the Science and Art Department to pass its examinations; but they would assist students of technology by giving them the exact kind and amount of preliminary instruction which would enable them to profit by the specialised teaching given in the technical classes. The progress of the student in these junior classes might be tested by examinations, closely following the courses of instruction pursued in the school. But the question of examinations is less important. What is wanted is the institution of classes for the instruction of young persons after the school age, in subjects that would lead up to distinctly technical studies. Such classes would form what the Germans call *Fortbildung* or continuation schools, and they would prove of the greatest use in preparing apprentices for technical teaching, and in raising the standard of instruction.

This is another direction in which we may look for some improvement in our evening technical classes.

Training of Teachers.

But in order that this, or any other kind of improvement, may take place, we must endeavour to secure a more systematic training for our technical teachers. This is a matter

which is forcing itself upon public attention, and requires careful and serious consideration. The Central Institution in London, and some of our university colleges in the provinces, are training a large number of engineers and chemists, some of whom become competent teachers in technical and other schools. But the conditions of study in these colleges, and the character of the instruction, are not such as to attract the class of persons who would be likely to become the teachers of evening trade classes. The teacher of a technological class should be, or should have been, himself engaged in the trade or industry connected with the subject of his instruction. Although good teachers may, in some industries, be obtained from among those who have been trained first in a technical college, and who afterwards have practised in commercial works (which course is to be recommended to those who have the time and means to follow it), the greater number of technical teachers, particularly of evening classes, will continue to be selected from among artisans. To convert such artisans into competent teachers of trade classes, means must be found for selecting those who would be likely to make good teachers; and provision must be made for giving them an adequate supplementary education. How is this to be done? At present, certainly in London, there is no recognised system for the training of teachers of evening technical classes. In one very important subject an experiment is about to be tried by one of the City companies. The Plumbers' Company, recognising the importance of securing properly trained teachers for the plumbing classes, the number of which has of late so largely increased, has arranged to offer, under certain conditions, free studentships to select students of existing plumbing classes. These studentships will be tenable at King's College, London. The students to be selected must be plumbers, and will be required to have passed an examination in the theory and practice of their trade. They will then be required to attend a course of lectures and laboratory instruction, under the professors of the college, in physics, chemistry, and sanitation, and in the applications of physical and chemical science to sanitary problems. It seems to me very desirable that similar opportunities should be afforded to artisans engaged in other trades of receiving the special training which may qualify them to act as teachers. In London, some institution for higher education, well-equipped with laboratories for the teaching of pure and applied sciences, should undertake the important work of training technological teachers. To do this effectively would require funds for the payment of the students' fees, and in certain cases where systematic day instruction is needed, for giving pecuniary help, by way of exhibitions, to the students. It requires also special arrangements for instruction adapted to this class of students. Among the several bodies who are at present acting independently, and are assuming the control of technical education in the metropolis, it is difficult to say on whom this responsible duty will ultimate fall.

Secondary Education.

Having said so much about evening technical instruction, to which a large part of municipal, charitable, and State funds is now applicable, I pass on to another part of my subject, and I must point out that it is only possible, in the limited time at my disposal, to consider certain phases of the difficult problems which the organisation of technical education suggests, and to indicate some few of the directions in which experience shows that we may look for further improvement.

If the knowledge of Continental systems of education has taught us anything, it is that the provision of a suitable training for the working population of this country requires that we develop and organise our intermediate and secondary schools.

"The best preparation for technical study is a good modern secondary school." This remark of the Technical Instruction Commissioners is true of the higher, as well as of the more elementary, grades of technical education. It applies to managers of works and the professional engineer, and also to the foreman and artisan.

Now, nothing is more satisfactory than the improvement that has taken place in elementary education during the last ten years. The teaching has been made free and practical; free, in the sense of being gratuitous and unfettered by the system of payment by results; and practical, by the introduction into our schools of workshops, of improved science teaching, and by the more general instruction in drawing. But, as regards intermediate and secondary education, as regards the facilities afforded for the further training of the children who leave our elementary schools, matters are very little better than they were in 1883, when I read a paper on this subject to the members of this Society. In that paper I said: "Of schools adapted

to the requirements of children of the artisan classes—schools into which the picked pupils from the elementary schools might be admitted, and where they would receive an education which would train them as intelligent workmen or clerks, there exist at present only a few isolated examples." Since then the number of such schools has increased; but they still constitute "only a few isolated examples," instead of being, as they should be, organically connected with the public elementary schools of every district throughout the country, forming the intermediate link between the training of the primary school and that of the workshop or technical institute.

Want of Intermediate Schools.

It is between the ages of 13 and 16 that the means of education are so markedly defective. In many of our large provincial cities schools have been established to meet this want. They are found in Manchester, Birmingham, Sheffield, Bradford, Leeds, Coventry and elsewhere; but in London the number of such schools is still out of all proportion less than the needs of the population demand. No fact has been brought out more clearly than this in the report of Mr. Smith, to which I have already referred. He tells us that there are in all London only 26 secondary schools under public management, "charging fees varying from £3 a year up to £12 12s., but averaging about £6 a year," and these are very unevenly distributed throughout the Metropolis. Some of the elementary schools, it is true, have higher departments for ex-standard children; but I know of few, if any, schools in London which can compare with the higher grade schools at Leeds, Bradford, and other places. The day schools in connection with the Regent-street Polytechnic and the People's Palace approach these schools, but cannot be said to equal them in efficiency and organisation. I have always regretted that the School Board for London was not able to follow the example of other School Boards, and establish higher grade schools of this type.

In my address on this subject in 1883, which, with some additions, forms a chapter in my book on "Industrial Education," I showed the great excellence of the French intermediate schools, and I described very fully their curriculum of studies; but at that time I knew of no funds available for the establishment of such schools. Since then, the curriculum I indicated has been, to a great extent, adopted in many of the schools, the schemes for which have been prepared by the Charity Commissioners. What, however, I could scarcely have anticipated has now come to pass. Funds have been found from wholly unexpected sources, and have been placed at the disposal of local authorities, which, ten years ago, had no existence, and are now available for assisting secondary schools. A Bill, too, has already been introduced into Parliament for increasing these resources, and for creating a system of intermediate education for England. The action of the Charity Commissioners in utilising endowments for the establishment of intermediate and modern secondary schools is one of the most promising educational movements of the last ten years. It is to schools of this kind, properly equipped and conducted, that we must look for the adequate preparation of the children of our industrial classes for that apprenticeship to trade and commerce which is found in the workshop or counting-house, supplemented by the teaching in evening technological classes. As is well known, young people too often forget, between the ages of 13 and 16, very much of what they have learnt at the public expense in the elementary schools. A German philosopher says, "Now and then one learns something, but one forgets the whole day long," and this truth is well illustrated by the amount of knowledge possessed by the ordinary clerk or apprentice when he enters a technical class.

Organised Science Schools.

A defect of many intermediate or higher grade schools, as at present organised, is the undue encouragement afforded to the teachers to work for payment on the results of the examinations of individual scholars in separate science subjects. The true purpose of the teaching of a day school I take to be the harmonious development of the intellectual and moral faculties of the pupil, by means of instruction in subjects, knowledge of which will be useful to him in after life; and this purpose cannot be kept sufficiently prominently in view, if *instruction* only for the purpose of passing an examination is the goal aimed at.

In the so-called "organised Science School" there is too often a want of organisation—a want of system in the order and method of the studies. The element of gain enters too obtrusively into the curriculum, and the teaching of science is controlled to too great an extent by the endeavour to secure the maximum grant towards the school funds. Under such conditions sufficient freedom can-

not possibly be left to the school teacher, and the disciplinary value of science, as a mental discipline, is partly sacrificed to the effort to secure such knowledge only as can be best tested by examinations. Who can say if the study of the classical languages would have ever become the instrument for training the mind in logical method, accuracy of thought, analysis, and research, which, in the hands of the best teachers, it has undoubtedly been made, if the teachers had been trained in schools in which their freedom and spontaneity had been restricted by an examinational system associated with money grants? Moreover, there is a tendency in some of these schools to neglect such subjects as language, literature and history, in the scramble for grants on the results of examination in science; yet no one can for a moment suppose that the analysis of a salt, however skilfully the operation may be performed, can have the same influence upon character as the study of the best thoughts of our best writers, and of the forces that have moulded our constitution into its present form. When the Royal Commissioners said: "The best preparation for technical study is a good modern secondary school," they had in their minds a school which gives an all-round complete education, one in which the faculties of the mind are so developed as to enable the pupil to take full advantage of any subsequent training he may receive.

These defects in the management of science schools are mainly due to the conditions under which they receive State aid, and to the fact that they are largely assisted by grants on results of examination in Science and in Art, without reference to the general education, in which the teaching of these subjects should form a very important part, but still a part only. In many of these schools the real problem which the complete education of children of this age presents does not appear to have been fully or carefully considered, and this is largely due to the mere accident that such schools have not been created for the purpose they have to serve, but have grown out of the arrangements for the evening instruction in Science and Art of adult artisans. Even the hours of examination are fixed for the evening, at times when boys between the ages of 13 and 16 may not be expected to do full justice to themselves.

The great change which is needed to place these schools on a satisfactory footing is to substitute for the payment on results of individual examination in separate subjects a system of inspection of the work of the scho *as a whole*, and the payment of capitatio grants under suitable conditions as to th course of study and methods of instruc tion. Further, these schools should stan in close relation with the ordinary ele mentary schools below, and with the techn cal colleges above, and should serve a a connecting link between the one and th other; and in order to enable pupils of th poorer classes to secure the advantage c higher education, scholarships, increasing i value with the pupil's age, should be estab lished in sufficient numbers. These importan matters are no doubt now engaging the seriou attention of the Departmental Commissio which has been appointed for the purpose and we may look forward to the results of th labours of that Commission to co-ordinate th work of the Whitehall and South Kensingto offices, and to give us, what this country doe not yet possess, a central authority for second ary education, defining the conditions of Stat aid, and exercising a general supervision ove schools receiving Government assistance Considerable progress has already been mad by the Charity Commissioners in the provisio of good modern schools, and there is ever prospect of their work receiving further en couragement and endowment from the fund now being used by County Councils.

Local Educational Authorities.

And this brings me to consider the ver important question—under what local bod should the direction and control of inter mediate and secondary education be placed In England, institutions are evolved and nc created; and the gradual evolution of ou systems of primary and technical educatio has already resulted in a division of local con trol, which is likely to give rise to some con fusion and duplication of effort, and wil undoubtedly, require adjustment in the nea future.

It is now generally recognised that technica instruction is not a distinct and separat kind of training, but is closely associate with elementary and secondary—includin evening—education; and it has, therefor been suggested, and with some show reason, that the direction and control all three departments of instruction shou be placed in the hands of one and the san governing body. Till recently, the only loc educational authority was the School Boar but, within the last two years, county council

ıd, through them, city and borough councils ıd urban sanitary authorities have, by the cts of 1889 and 1891, been constituted by ırliament local educational authorities, and ıve, it must be admitted, shown consider- ıle activity in devising schemes for the ilisation of the funds placed at their sposal for technical instruction. Already, erefore, two local authorities exist, charged th the organisation and management of ıpular education. It is proposed, too, in a ll just published, to promote secondary ucation in England, to extend the powers the county and municipal authorities by abling them to impose a new rate, not ceeding one halfpenny in the pound, for e express purpose of establishing and sisting secondary schools; and it is also oposed to constitute the Technical Instruc- ın Committee, where one exists, the com- ittee for secondary education; and, where no ch committee exists, to appoint a new mmittee for this purpose, on which the Local :hool Board is to be represented. Now, it nnot be denied that there is some incon- nience in a dual control, and that some erlapping of functions and want of economy administration and teaching power must sult from the action of two independent educa- ınal authorities. In London and elsewhere, hool boards are giving technical instruction their own schools. They are also engaged organising and assisting evening classes in awing and science, for which help might obtained from the County Council funds. oreover, in many of the large provincial wns they have established, and maintain, th the help of grants from the Science and t Department, day science schools, which e, properly, secondary schools. All these :ts point to the desirability of some change the constitution of school boards, and, ssibly, of some rearrangement in the educa- ınal functions of county councils.

RECONSTITUTION OF SCHOOL BOARDS.

It is contended by many School Boards ıt they are the only "representative bodies thorised by Parliament for purely educational rposes," and that they should be charged th the administration of all funds, both such are obtained directly from the rates, and ch as are at the disposal of local authori- s for educational purposes. There would, tainly, be many distinct advantages in ıcentrating the direction and control of ıcational matters in the hands of one local educational council; but it is very doubtful whether School Boards, as at present consti- stituted, are the most fitting bodies to assume these enlarged responsibilities. It is true that the members of the School Board are elected for purely educational purposes. But can it be said that this consideration weighs with the electors in their choice of a candidate? Preference is often shown to a candidate on religious grounds, or according to his disposi- tion to spend more or less on the education of the people; but candidates are seldom elected for their special fitness to sit at a Board charged with the most responsible of all duties—that of regulating the education of the people. If the experience of nearly a quarter of a century of School Board admini- stration had shown that the elect of the rate- payers were men distinguished in science, literature, or art, or men who had served an apprenticeship in educational work; if the published reports of their discussions had shown that the members gave the same serious attention to educational problems as they do, say, to religious and other matters, it is possible that the Legislature would have recognised the School Boards as the proper educational authorities throughout the country, and would not have entrusted to other bodies equal, if not more responsible educational functions. I would not for one moment suggest that School Boards have failed in the great work which they have undertaken; but it cannot be contended that the School Boards throughout the country, although elected for educational purposes, are largely composed of men having any distinct or special qualifications to direct a great educational movement. Men, so qualified, having no personal end to serve, but willing to assist in directing the education of their fellow citizens, are often prevented by the trouble and expense of a popular election from taking part in this important work.

It is evident that if our School Boards are to become local educational councils, with enlarged functions, which some aspire to be, they must be prepared for certain organic changes in their present constitution. And why not? It is generally admitted that education should be continuous, that there should be a close connection between the primary and secondary and technical instruc- tion of our artisan population; and further, that a dual control, a dual authority entrusted with the expenditure of money, is undesirable. The members of the London County Council have

set an excellent example. They have delegated the exercise of their powers to a composite body consisting of members of their own body, and of representatives of the School Board and of other interests. Would it not be possible so to modify the constitution of our existing School Boards, as to secure the presence on those boards of men specially conversant with educational questions, and qualified to act as members of a council charged with the administration of secondary as well as primary education ?

An Educational Council.

Some of the best educational work that has issued from the School Board Offices of London has been done by a joint committee, consisting now of representatives of the School Board, the City Guilds Technical Institute, the Drapers' Company and the County Council, and of co-opted members. It is to this joint committee that we owe the success of the educational experiments which have resulted in the introduction of manual training and laundry work with the Code, and which will probably lead to the recognition by the State of housewifery as a subject of technical instruction for girls. The same committee, with funds placed at their disposal by the Drapers' Company and the City Guilds Institute, have also arranged advanced courses of instruction in these subjects, for the training of male and female teachers, and are now occupied with other educational work, for which the funds of the School Board are not available.

These precedents ought not to be lost sight of. They suggest the introduction of new elements in the constitution of our School Boards.

It is, of course, essential that the ratepayers should be directly and largely represented on any newly-constituted educational council. In their hands is the power of the purse. But there are other interests besides those of the ratepayers which have a right to recognition on such a council. The contributions of the State bear a much larger proportion now than formerly to the total cost of education in Board Schools. There are grants from Whitehall and from South Kensington. These grants, on the most purely democratic principles, should carry with them representation. Then, too, there are ancient endowments, the administration of which is from time to time entrusted to these boards; and if the educational powers, recently acquired by municipal bodies, were to be vested in a single educational council, it would be necessary that these bodies shou be duly represented. Without, therefo entering into any of the many details whi would have been considered before such a constitution of our school boards could effected, I venture to suggest that, if in t future there is to be only one local educatio authority, it should be a Council consisting members, a portion of whom, say one half one-third, should be elected directly by t ratepayers, whilst the other portion should composed of representatives of the munici body, and so indirectly of the ratepayers, nominees of the State Education Departme and of the local University College or place higher education. The Crown nominees wo be selected from the locality, on the adv probably of the inspectors, and should persons of either sex, conversant with, a interested in, educational matters. Such council would be competent to deal with t whole area of popular education. Th would be no rivalry, no conflicting interests, overlapping of functions, with the consequ waste of energy and money. Moreover, would be a body clothed with the autho acquired from the citizens it would represe and with the additional authority due to special qualifications in knowledge and perience of some of its members. Ten ye hence, perhaps, if I am then again permit to address you, such local educational counc may have been established. Meanwhile, mu may be done to prevent the inconveniences dual control by joint committees and by co-operation of those bodies which are t present concerned with the administration f funds for elementary, secondary, and techni instruction.

Future Progress.

I have now indicated some of the directi in which, in the near future, improveme may be looked for in organisation of popu education. There are many subjects to wh I have not been able even to refer. T problem of agricultural education is still u solved, and the attempts made by Cou Councils to teach butter-making, bee-keepi the care of crops and the rearing of sto by means of itinerant lecturers, must be garded as in the first period of the expe mental stage. Nevertheless, out of su attempts, method and system will undoubte be evolved; and, although one cannot, I fear, report great progress in this directi the prospects are encouraging. To

stion of higher education I have only n able to make very scanty reference. In ny ways the present must be regarded as a iod of transition. Much has been accom- shed, but, with the means now placed at disposal, we look for greater progress in future. The results of the inquiries of ious Commissions have established the essity—if we are to hold our own in com- ition with foreign countries—of extended hnical and secondary education, and have wn how far behind foreign countries we l remain in the facilities and provision for h education. We have learnt something to the best methods of technical instruction, l the limits of its applicability. We possess length the funds, or the means of obtaining funds, for providing the kind of education t is needed.

ORGANISATION AND CO-OPERATION.

Vhat is now wanted is the co-ordination our resources and the simplification of machinery. The Technical Instruction nmittees, with the help of their able retaries, are doing good and useful work, hough much of it is necessarily impeded the restrictions of the Acts of Parliament ler which they work. Between these bodies l the School Boards there should be earnest operation. To these bodies, acting together, l strengthened by the representatives of er educational interests, should be ulti- tely submitted the duty of making that her provision for secondary education, need of which is generally admitted.

n London a great work has yet to be omplished. The action of the London nty Council marks the beginning of a new cational era, and cannot fail to stimulate h and useful efforts. But it needs intel- ent direction. The creation of a new rce of revenue, and the imposing of new ditions on grants, will necessitate some re- ustment in the existing educational ma- nery. Unless carefully avoided, there may a duplication of effort and a conflict of hority in the working of the Polytechnic In- utes, between the Central Governing Body, ently created by Act of Parliament, and the hnical Education Board of the County ncil, about to be formed. The problem is an easy one. Whilst our technical insti- s will be supported by these two bodies, ed by grants from the Government and from City Guilds' Institute, each of which has ie directing influence upon the educational work, our School Board is taking an active part in elementary technical teaching, and in the development of continuation schools, and to that extent is already undertaking part of the work which the County Council has marked out for its own Board. Out of all this laud- able and independent activity there may one day be evolved something approaching to an educational system. Meanwhile, we are still waiting for a legislative measure to organise our secondary education; and we are watching with interest the labours of a Royal Commission, from which is expected to emerge a re-consti- tuted University of London, to crown and give unity to all other educational efforts in the Metropolis. But on this troubled sea I will not ask you to embark.

DISCUSSION.

Mr. J. L. S. HATTON thought that the People's Palace had been rather severely criticised in comparison with some others, but it had obtained the largest grant of any in the country from South Kensington, and he considered the work done there was deserving of some encouragement. He did not wish to take up a position in any way hostile to the City and Guilds Institute, but he believed the number of passes from the Regent-street Polytechnic was four times as many with regard to schools for boys between 13 and 16. The difficulty they found was that boys of that age did not sufficiently appreciate the advantages of education. In the East End of London boys went to work at 13, and were employed all day. They were not much inclined then to attend classes; and it was not until the age of 16 or 17 that they began to attend much. Sir Philip Magnus had said that technical education ought not to interfere with the apprentice-ship system, but he believed, from some experience, and his opinion was confirmed by leading Trade Unionists, that the apprenticeship system was rapidly dying out. His experience of about 5,000 students was that most of them were nominally apprentices: they were not really taught their trade, and if they wished to learn they sometimes had to bribe with beer the men to teach them. It was not the object of masters, foremen, or workmen, to teach a boy his trade, but he was kept to one particular branch, and never made a good workman. This condition of things technical education ought to endeavour to prevent. The examinations of the City and Guilds had been of great advantage; but he feared they were adapted rather to the foremen and advanced workmen than to the rank and file. Personally, he thought the most pressing need was a system of examination and certificate which should assist a competent workman in getting employment, which he should look upon as a University man looked upon his degree. He was quite sure that such a thing would be

appreciated by the workmen, and would be welcomed by the trades' unions. To carry out such a scheme the examiners should not be professors, but practical workmen and employers, whose names would be a guarantee for the genuineness of the certificates. Another point of great importance was that the examination should not be written but *viva voce.* Under the present system of written examinations, a clerk, who had crammed up a subject, and was able to express himself in writing, had an immense advantage over a man who had a thoroughly practical knowledge of the subject, but was not so well able to write about it.

Mr. R. F. FRASER thought that one of the most satisfactory portions of the paper was that which dealt with the subject of the reform of the School Boards. From his own observation in the rural districts, he found an almost total absence of information on the part of School Boards of how educational work was carried on in large towns; and, in the course of some conferences on the subject, he suggested that there should be a distribution of literature bearing on the subject. He was indebted to Mr. Llewellyn Smith for a list of works, which, he believed, was the only one anything like complete. He took particular interest in one branch of the subject dealt with in the paper, viz., the position of elementary schools in connection with technical education. In the rural districts, the state of education was very deficient, and there was an entire lack of sympathy on the part of many boards, and even of teachers, with technical education of any kind. The great thing needed was a reform in the School Boards. It was an old Liberal maxim that representation should go with taxation; and seeing that the Government contributed so largely to the education of the rural districts, it was absurd to place in the hands of some of the very incompetent men returned to those Boards the power of applying, not only the small rates they raised, but also the Government grants.

Professor ARMSTRONG, F.R.S., said that Sir Philip Magnus evidently understood technical education in the sense in which he (the speaker) had always understood it, but in which, he was afraid, it never had been understood in this country, namely, as including the whole question of education. He had always thought that this problem had been attacked in a peculiarly English, but very stupid way, with no sort of system, but by a succession of random experiments. Giving evidence before the Gresham University Commission, he was asked why there was such a difference in educational matters between England and Germany, and especially in post-graduate education, and he said there was one word which English manufacturers and the public did not understand, and which all Germans did understand, and that was the word research. No attempt had been made to collect the result of experience in this matter. Mr. Llewellyn Smitl n his report to the London County Council, had n e the sad statement that he (Professor Armstro , amongst all the scientific workers of the day, was e only one who had given any attention to the teac g of scientific method to children. He believed t was a fact; he had many friends immensely intere d in the question, but they would not work at t. They would talk about it, and even use strong lang ge —in private—but they would not do so in pu c. There had been an enormous amount of destru ve criticism on these matters, but very little construct ; and that was why Sir Philip Magnus' paper w so valuable. He was one of the first three professo t the Finsbury College, and he had written a good al on educational subjects; and yet, up to the pre nt time, he had not had, outside his own boc a single application from any quarter for informa on or advice. That was an illustration of the te of things; everybody who was set to do a ce of work of this kind had to find his n way, and do it as best he could. He was e- lighted to hear the criticisms passed on the Lo n School Board: they were fully justified, and, in t, were not strong enough. He was afraid that n ly every one at the elections acted simply as a ratep r, and not as a parent, or as interested in educa n. He was inclined to think that in the provinc a somewhat better feeling prevailed, and that, a y rate in the manufacturing districts, people were re alive to the importance of the work entrusted t e School Boards, and more careful in their selectic of members. If they took into account not the re number of children at school, but the charact of the methods employed, he held that, on the w le, the palm must be given to schools outside Lon n. The People's Palace was no doubt doing good rk of a certain kind; but the mere fact that the d had so many passes at South Kensington wa so far, an indication that they were not workin on proper lines. It was not the function of a tech al school to teach for South Kensington examinat s. Reference had been made to the success o he Finsbury College, and of the Central Institute. re were various causes for that success; they had e p- tional advantages at starting, in having funds p ed at their disposal, and another thing was that the ee first professors were three of the rankest educat al radicals it was possible to find. Sir Philip Ma us was associated with them, and they all agreed a he outset that they would have nothing to do with S th Kensington or any other examining body. It was at which mainly determined the course of teaching nd gave the College the position it occupied. The at thing wanted in England, as Sir Philip Ma us had said, was a system of graded instruction. At present they were trying to raise a crop on n- manured soil. The vast majority who came to h- nichal schools were not capable of swallowing he kind of educational food offered them. There wa oo

uch of it, and it was too rich for their digestion; id until this was recognised, there would not be that ·ogress which the public looked for. He was one of ie professorial class, and was regarded, therefore, ; a pure theorist. Nevertheless, he would venture , say that the practical man, pure and simple, had id his way far too long; we wanted more men ·awn into the question who looked at it more from ie educational side. Technical education was sup-)rted far too much on the ground that it assisted en to earn more butter for their bread. It was a istake, even from that point of view, for in the long in, as at present practised, it did not lead to that re-ılt; and it led to the butter being put on at such a ow rate that it turned rancid before it could be ›read. To get better results in future they must pay ore attention to the preparation of the material. Up , now they had been acting too much on the lines of any English manufacturers; they were prepared to) any amount of business on a large scale, to turn it a large quantity of a cheap article, but not to under-ke a small order requiring special care and skill. was the same thing in education; they were ›ing a large business in an inferior article, en-:avouring to train a very large number of juniors, it not paying proper attention to the seniors. There as no proper system of post-graduate instruction, hich enabled them to send out leaders into the rious industries. Manufacturers, for the most part, d not understand the need for these men, and, erefore, there was not the demand. The students ere not forthcoming, and the national industries ll back. He was asked at the Gresham Commis-)n what evidence there was that, in Germany, ey were availing themselves of this higher educa-)n, and in reply, he referred to a paper, the *hemiker Zeitung*, giving an account of a labora-ry at one of the large colour works at Elberfeld, which he now produced some photographs. here were two floors, on each of which there were elve men at work in pure research, and each man d about four times the space that his students had the Central Institution. Besides these, there were e director and about forty chemists actually em-oyed in the works. If he were called upon to sign a laboratory for higher work in chemistry, he ould adopt the plans of that establishment, and he uld then congratulate London on having the best)oratory in the world. There were many other ›rks in Germany similarly provided, but there were English Works in any of which six chemists were ıployed.

Mr. R. A. HADFIELD said that he knew plenty of orks where a considerable amount of research was ried on. He came from Sheffield, where they were rying out technical eduction on special lines some-at approaching these indicated in the paper. When school was founded the Firth College was already existence, and, with that example before them, he ›ught they had organised a much better system. They had not only members of the Town Council (which granted large sums of money) on the committee, but many specialists, who gave valuable assistance. They also had help from some of the London Companies, and Sheffield was the first borough to take advantage of the Technical Instruction Act. In the last three years they had spent something like £14,000, and starting with 90 students, they had now 191 day and 490 evening students. From the school had sprung a Society of Engineers, a Society of Metallurgists, and several others. The teaching was practical as well as scientific, and with all deference to Professor Armstrong, he thought the practical side ought not to be lost sight of. The students were taught to make the crucibles to melt the steel, cast it, forge it, and turn it into finished tools. They had also an open hearth furnace, which would melt nearly 12 tons, and they also carried out foundry work. The same thing was carried out in engineering; several engines and tools had been constructed by the students, and though the learned Professors were apt to look on such things as toys, he thought that if Prof. Armstrong would pay them a visit, he would be satisfied that they were really doing good work, both practical and theoretical. In consequence of the work done there, much greater interest was taken in the town in all scientific matters. Owing to the rapidly increasing complexity of modern improvements, as shown in electric lighting and telephonic engineering, such schools were becoming a necessity; but it was necessary to take great care that they were properly and efficiently carried on. They were much assisted by the beer money being devoted to brain work, but still the utmost economy ought to be practised. He had travelled a good deal on the Continent and in America, and had often heard Germans express their admiration for the practical side of English training.

Mr. HOWARD SWAN said that Professor Armstrong had very properly insisted on the necessity for more research; and there was one field in which not much had yet been done, and that was the science of education itself. As far as he knew, there was no real science of education yet; it required formulating. There were fundamental principles which underlay the art of learning any subject, and conceivably they might be established as firmly as Dr. Joule established the mechanical equivalent of heat. In text-books, again, there was plenty of room for scientific development, so that a person might begin at the beginning and work right through a subject, and understand it as he went. There was also the question of making education, or the drawing out of the faculties, co-ordinate with practical utility. The old education which came down from the classicists and Jesuits tended largely to destroy the reasoning faculties, and to make the book stand in the place of nature. Even now, in nearly every branch of science, they were confronted with the fact that the child thought the book was the thing he had

to learn, rather than the reality which lay behind it; and very often the teacher did not enlighten him. There were in certain natures faculties called genius, in virtue of which children rapidly developed the power of solving problems, or accomplishing mental feats in a way impossible to most educated men; some developed a talent for art, some for music, and so on. He ventured to suggest that this was not a special gift of genius, but rather that the persons referred to had discovered the science of educating themselves; and the question was, could not this science be discovered and made generally available? He had been engaged for some years in making experiments in the fields of languages, geometry, mathematics, and music, and had had some very extraordinary results. The question was whether they were following nature in the method and teaching; he thought not. He remembered examining a class in electricity, who had had six or eight object-lessons, and out of sixty, there was only one who seemed to have any idea of what he was asked, and that a very partial one. He thought the introduction of the abstract, in any form, until the very end of the course, was the root of the evil. He remembered, when attending the Finsbury College, the state of haze he was in for three months, as to the various electrical experiments he had to go through. Lord Kelvin had stated publicly that any average intelligent man ought to be able to learn what he wanted to learn of practical electricity in three months; but that was the time he (Mr. Swan) spent in trying to find out what it was about. South Kensington had not solved the problem, and he thought there was a great field for pedagogic research.

Mr. HUGH STANNUS regretted that Sir Philip Magnus had appeared to rather give the go-by to the study of technical art, in devoting so much attention to science, but presumed that he did not mean to do so really, however. The principles he had laid down were admirable, and doubtless would be more and more kept in mind; but he could not help thinking that sufficient had not been made of the point mentioned by the last speaker, the scientific method of teaching. When he was first appointed at South Kensington, he found there had been no scientific method of teaching drawing. He was quite certain, however, from his own experience, that there was a scientific basis for it. Of course, teachers should be men of practical experience, like Prof. Armstrong himself. He could not be too thankful to Sir Philip Magnus for what he had said against the wretched system of payment by results. With regard to the London School Board, it was a disgrace that so much time had been wasted lately in the introduction of hair-splitting discussions on questions of polemic theology, instead of attending to the proper business of the Board, and all people of right feeling would agree that it had abdicated its functions, and must give way to the Central Board Sir Phil Magnus had sketched out. He had spoken honourable terms of the County Council, but n too highly, for it was really waking up to the war of London and endeavouring to supply them.

Mr. C. T. MILLIS, who said he held a corr sponding position in connection with the Boroug road Polytechnic Institute with that occupied Mr. Hatton at the People's Palace, said he c not agree with all the remarks of that gentlem The Finsbury Technical College, with which was formerly connected, never professed to prep its students for South Kensington or any particu examinations: they were all free to go up or n He cordially agreed with the four principles l down in the paper, but he thought some the remarks with reference to the combination education and recreation were somewhat open question, at any rate in London; but it was i portant that the social work should not be allow to interfere in any way with the educational. Wh an appeal was made for funds, the educational s was put in the forefront, and it was very necessa therefore, that it should have the first attenti Owing to the gradual way in which the Rege street Polytechnic grew up, a system of members and non-membership had crept in, and it was san tioned by the Charity Commissioners, but it had s to prove its practicability. He could not agree w Mr. Hatton that the main object of the examinati of the City and Guilds Institute was to provide the case of foremen, having had something to with the preparation of the syllabus which came i operation in 1885; they were intended to meet case of artisans generally. There was a li danger of pandering to the subdivision of tra and industries, which went on in some cases t ridiculous extent; and there was, therefore, a n for some directing body which should put educat on a wider basis. For instance, a zinc-worker that he had no right to touch a piece of tin, iron any other sheet metal; but if technical instr tion were worth anything, those who profited b should not be mere machines, and if they could get work in one branch should be able to turn something else of an allied character. He cordi agreed in the view that better preparatory instruc was needed by those who wished to take up particular branch of technical knowledge in conn tion with their trade, but there was always m difficulty in inducing a workman to study mathema than something which he thought more prac and more minutely connected with his trade.

Mr. C. J. DRUMMOND was delighted with paper, and hoped some special steps would taken to circulate it amongst artisans. It would great way to dissipate the opinion, which he knew

ery widely held amongst Trade Unionists, though he as convinced it was erroneous, that the object of ie employers in promoting technical education was) enable workmen to produce more in the same time. . was very important that sounder information should e diffused on the subject. He had been able to iduce some of the better employers in his own trade, ho took a real interest in their craft, to give their pprentices time to attend technical classes, instead f having to do so at the end of their day's work, when iey were tired out. He was, however, sorry to say iat the experiment failed, many of the lads using the me to go elsewhere, and so the employers were com- elled to withdraw the privileges they had accorded. Vhat had been said with regard to Polytechnics ould, he believed, apply much more to provincial wns than it would to London, where the conditions ere in many respects different.

The CHAIRMAN, in proposing a vote of thanks to ir Philip Magnus, said the paper marked an era in chnical education. No one was better qualified ian Sir Philip Magnus to speak on this subject, id he had touched on every point which was con- ected with it directly and indirectly, unless it were iat of University education, which he was very arly going into. He (the Chairman) hoped that a cond part of the paper might appear on some ture occasion, when the Industrial University would dealt with. He trusted that the Gresham Uni- rsity, when it came, would give an example of what Technical University might be. There was one kind education, however, which had not been touched on, and that was the education of the public ind during the last 15 years. Any one who uld go back mentally for that period would re- ember that those who believed in technical educa- on were few and far between, many people saying ere was no such thing worthy of the name, id ordinary practical men did not consider it ssible to combine theory and practice. He was ry glad to hear Mr. Hadfield say, as a practical an, that he recognised the great benefit which had en derived from the theoretical study of practical estions. This subject had been advancing for the st 15 years very materially in the public mind, til at the present time few were found who did not lieve in practice in the workshop being closely nnected with science in the school. The only estion was how best to combine the two. He ite agreed with Mr. Drummond that it would be ry desirable that this paper should come before a ltitude of people who, in the ordinary course, it uld not reach. Of course, it would be published the Society's *Journal*, and widely circulated among members, and to institutions where it might ich the eyes of artisans. He had for some years ken part in this subject, in connection with the y and Guilds of London Institute, and was glad find that the efforts made and the money expended had borne good fruit. The technological examinations, which had now 8,443 candidates, were started by the Society of Arts, about 20 years ago. When they were taken over by the Institute, in 1879, only 200 candidates were examined, so that they had increased forty-fold, and he hoped that the same progress would continue. There was ample room for a large increase, and an opportunity for the expenditure of large funds wisely. He was very pleased to be able to say that that day the governing body of the City Parochial Charity Trustees, who had been invited by the London County Council to send delegates to the Technical Education Committee, had appointed Sir Philip Magnus and Mr. Drummond, so that both practice and theory would be represented; and he was quite sure that those two gentlemen would give valuable aid to the County Council.

The vote of thanks having been carried unanimously,

Sir PHILIP MAGNUS, in responding, said the paper had been written under great stress of work, which prevented it being as full and comprehensive as it might otherwise have been. He was sorry that he had no time to refer to the important question of the connection of Art with Industry; but that subject was quite wide enough for more than one paper. It was then too late to go into any details about the points raised in the discussion, but he welcomed very much the enthusiastic adherence of Mr. Hatton to the cause of education. At the same time, he was rather new to the subject, possibly owing to the natural reaction of his Oxford education; but before long he would render very valuable service to the cause. He (Sir Philip Magnus) recommended Mr. Hatton to adhere to the principle agreed to by all educationalists, that, under no circumstances, could the technical school be regarded as a substitute for lengthened practice in the workshop. Personally, he should feel disposed to distrust certificates given as a guarantee in lieu of apprenticeship, on any instruction occupying a few hours a week in a technical class.

Mr. JULIEN TRIPPLIN writes:—I should have been happy, profiting by a reference of Sir Philip Magnus to the industry of watch and clockmaking, to have represented the other end of the pole, that is to say, the masses, the people to be benefited by technical education; and alluded to a grievance, if grievance it be, under which we watchmakers suffer in examinations, had not theorist after theorist continued to expound the views as to the way in which that education should be conferred, until the president's bell put an end to the discussion. The only gentleman who touched at all upon that question in a practical manner was Professor Armstrong, when he asked in homely language whether the "butter was not too thick on the bread?" and I have no hesitation in saying, so far as my own

industry is concerned, that he is right. I am acquainted with technical schools of watchmaking abroad, having passed through one of them, and a chapter of the book which I wrote in 1889, on the Paris Exhibition, was devoted to that subject. I have translated into English, and published Saunièr's standard works on horology, I am Vice-President of the British Horological Institute; and visit every year the schools of Aberdeen, Edinburgh, and Coventry, and I have no hesitation in saying (1) that the butter is laid on too thickly for beginners; and (2) that the questions asked should be of a more modern character, and more appropriate to the present two distinct requirements, viz., manufacturing and repairing. That the present system does not fulfil every aspiration is proved by the fact that so few follow the classes, for I cannot consider the figures quoted by Sir Philip satisfactory. That the number of candidates for examination increased from 2,397, in 1882, to 8,443, in 1892, is not altogether a success; and that absence of success is only explained, to my mind, by the fact that the food which the pupils have to swallow has not been rendered sufficiently palatable, or has not been administered by proper hands. I cannot help regretting that the grant of the City Guilds should have been taken away from the Clerkenwell Horological School. There, at least, the pupils obtained a congenial education, given by professors *ad hoc*, who took a delight in giving it; and the advantage of education being imparted by men of the same trade, who have passed through the same routine, and had the same object in view, viz., the subsequent intelligent earning of wages (because, after all, everything ends in that), is evident. The Committee of the Council of the Horological Institute, formed for granting certificates to repairers some three years ago, has resulted, up to the present, in upwards of 70 certificates being granted.

Miscellaneous.

THE CONCENTRATION OF POPULATION IN AUSTRALASIAN CITIES.

The growth of the population of the Australian capitals, Mr. H. H. Hayter, C.M.G., Government Statistician in Victoria, points out, has been even more marked than that of the cities of the old world. Thus in the 10 years ended with 1891, the population of Greater Melbourne increased from 283,000 to 491,000, or by 74 per cent.; that of Sydney from 224,000 to 387,000, or by 72 per cent.; and that of Adelaide from 104,000 to 133,000, or by 28 per cent.; whilst in the five years ended with 1891, the population of Brisbane increased from 74,000 to 92,000, or by 25 per cent. Melbourne contains 43 per cent. of the population of Victoria; Adelaide 42 per cent. of that of South Australia; Sydney, 34 per cent. of that of New South Wales; and Brisbane 23 per cent. of that of Queensland. London contains 19 per cent. of the population of England, and less than 15 per cent. of that of the United Kingdom. Paris contains less than 6 per cent. of the population of France; Berlin $5\frac{1}{2}$ per cent. of the population of Prussia, and 3 per cent. of that of the whole of Germany; Vienna less than 5 per cent. of the population of Austria, and less than 3 per cent. of that of the whole of Austria-Hungary. The increases which have occurred, and are occurring, indicate that when the census of 2001 is taken, half the population of Victoria and, perhaps, also half that of South Australia, and 40 per cent. of that of New South Wales will be living within the metropolitan limits. "That so large a proportion of the population of a country should be congregated in its capital city is, so far as I know," says Mr. Hayter, "a circumstance quite unprecedented: and for that reason no previous experience can afford an indication of what the effect may probably be." The balance of advantage, however, is, he thinks, in favour of cities being large and few instead of small and numerous. "The ev[il] arising from there being several small or medium sized centres of population instead of one larg[e] centre is shown in the case of New Zealand, which in consequence of its divided and insular formation has, necessarily, a number of towns situated at vario[us] parts of its sea coast, with railways branching o[ff] from each town. That New Zealand suffers fro[m] this state of things is well known; one effect of [it] being that of all loans to be raised, or public mone[y] to be spent, each centre claims to have a share, n[ot] because it is actually wanted, but in order to gi[ve] work in the district, with the result that not u[n]frequently useless railways are made, and unnecessa[ry] public works constructed. This scramble for t[he] public funds has, besides, as may well be imagine[d,] a demoralising effect on both electors and legislators." We are reminded that large towns of recent grow[th] cover a large surface in proportion to populatio[n;] Greater Melbourne is officially considered to exte[nd] over an area having a radius of 10 miles from t[he] centre of the city; that by means of cheap trains a[nd] trams, town workers are enabled to live in t[he] suburbs, and that, in consequence, slums with th[eir] depraved and unwholesome concomitants beco[me] proportionately reduced in number and extent.

Mr. Hayter strongly recommends that through[out] Australasia the census should be quinquennial, as [in] Queensland and New Zealand.

PRODUCTION OF FIBRE FROM THE DWARF PALM IN ALGERIA.

The French *Monde Economique* says that [the] dwarf palm, which furnishes considerable quantit[ies] of fibre, grows in great profusion in Algeria, and [is] one of the principal obstacles to the clearing of [the]

so thickly does it grow and so difficult to pull ts roots, in shape resembling carrots, penetrate he ground to the depth of a yard or more, and its stem is only cut, it sprouts out again almost :diately. As its name indicates, this palm is small, and can only attain a certain height when cted, as in the Arab cemeteries, for example. ›us uses are made of this plant; its roots serve mbustibles, a light kind of coal being made out em, and the natives have employed the fibres they extracted from the leaves and the stems, d with camel-hair or wool, in the manufacture of ; for tents; with the leaf itself they make ets, mats, hats, fans, bags, and other articles. iiderable attention is now being paid by the orities to the encouragement of this industry in :ria, as, in the first place, it affords to the Arabs ısy means of making a living, and, in the second, and is thus rapidly cleared of this parasite. The of embarking in the industry of fibre production the dwarf palm, originated, a few years ago, with ıded proprietor living in Chéragas, about eight s from Algiers. At the present time there are, in :ria, numerous establishments which are devoted is branch of industrial enterprise. The principal ›ries are those of Aversing, Elaffroun, Chiffa, erré et Douera, and the exports of late years exhibited a decided increase. In 1880, the ıtity of fibre exported from Algeria amounted to 0,000 kilogrammes; in 1885 to 15,000,000 grammes, and in 1891 to 19,000,000 of kilo- ımes. In preparing the fibre, the following is the em adopted. The leaves are plucked by the bs, and carried into the courtyard of the factory green state, at a price of twenty francs per ton. they are at once used, and as they fear neither the nor the sun, it is only necessary to pile them on floor in a heap. The first operation consists of ing, which is effected by women and children. weeds are removed from the stems which fre- ntly adhere to them, and the broken or dried up es are cut away. Another operation consists in bing the leaves, or rather in carding them. This fected as follows. A workman holds tightly in right hand a handful of green leaves which he lies to a small carding machine. This machine sists of a drum on which some nails have been ghly fixed, and is constantly turning with great dity; to protect the hands of the workman it is ısed in wood with only an opening sufficiently e to admit the leaves. As it is necessary that e leaves should be damped during the work, ap is placed above the drum, from which a stant stream of water falls upon the leaves. th this most primitive system, a workman is able card from five to six hundred kilogrammes of es a day. When the leaves have been combed both ends, they present the appearance of a dful of rough and short fibre. They are then d, and, after a certain preparations, are ready use in stuffing chairs, couches, &c. To curl the fibre, a workman takes up a quantity of carded leaves and applies it to a bent hook, fixed upon the axle of a wheel, which is turned by a child. The first fibres accumulate round the hook, and wind themselves round it; the latter, which is constantly turning, draws in the others, and the workman recedes from the wheel while grinding the fibres with his hand. The latter soon constitute a sort of cord, one end of which is fixed to the hook, the other held firmly and horizontally by the workman. At this stage of the proceedings, the child who turns the wheel stops and detaches one extremity of the cord, which he returns to the workman, after having passed it round the hook. In this operation the cord is subject to the natural impulse of twisting and rolls up upon itself, so that it is only necessary to fix the ends so that it cannot come unrolled. The fibre is kept in this condition for several weeks, and is then untwisted, and is then considered to be sufficiently curled. African fibre is employed in its natural state or dyed. In the latter case, the fibres are passed through various solutions of sulphate of iron and logwood, then curled, and again plunged into the solution.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock :—

March 22.—"The Manufacture of Non-poisonous White Lead." By Perry F. Nursey, C.E.

Papers for meetings after Easter :—

"Transatlantic Steamships." By Prof. Francis Elgar, LL.D.

"The Construction of Locks and Safes." By Harry W. Chubb.

"Some Economic Points in connection with Electricity Supply." By Gisbert Kapp.

"The Optical Correction of Photographic Perspective." By H. Van der Weyde.

Foreign and Colonial Section.

Tuesday evening at Eight o'clock :—

March 21.—Cecil Fane, "Newfoundland." Sir Charles Tupper, Bart., G.C.M.G., will preside.

Cantor Lectures.

Monday afternoons, at Five o'clock :—

Prof. W. Chandler Roberts-Austen, C.B., F.R.S., "Alloys." Four Lectures.

Lecture III. — March 20. — Applications of Alloys in Metal Work, with special reference to the Art Collections in the South Kensington Museum.

LEWIS FOREMAN DAY, "Some Masters of Ornament." Four Lectures.

April 10, 17, 24; May 1.

C. HARRISON TOWNSEND, F.R.I.B.A., "The History and Practice of Mosaics." Two Lectures.

May 8, 15.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 20 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Cantor Lectures.) Prof. W. Chandler Roberts - Austen, "Alloys." (Lecture III.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on the paper by Mr. P. E. Pilditch, "Dilapidation Practice; particularly as Affected by some Recent Decisions," resumed.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Mr. R. Collins, "Buddha and the Light of Asia."

TUESDAY, MARCH 21...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Cecil Fane, "Newfoundland."

Royal Institution, Albemarle - street, W., 3 p.m. Prof. Victor Horsley, "Physical and Psychical Neurology."

Civil Engineers, 25, Great George - street, S.W., 8 p.m. Discussion on Mr. Thomas Sopwith's paper, "The Break-down of the *Umbria*."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. Stephen Bourne, "Progress of the External Trade of the United Kingdom in Recent Years."

Pathological, 20, Hanover-square, W., 8½ p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Dr. Edward B. Tylor, "The Tasmanians as Representatives of Palæolithic Man, with Exhibition of Tasmanian Stone Implements." 2. Prof. Politis, "Burial Customs in Modern Greece." 3. Rev. John Mathew, "The Cave Paintings of Australia."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Prof. A. Bostock Hill, "Trade Nuisances."

WEDNESDAY, MARCH 22...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Perry F. Nursey, "The Manufacture of Non-poisonous White Lead."

Geological, Burlington-house, W., 8 p.m. 1. Mr. R. Lydekker, "The Jaw of a new Carnivorous Dinosaur from the Oxford clay of Peterborough." 2. Mr. R. Lydekker, "A Mammalian Incisor from the Wealden of Hastings." 3. Mr. George Barrow, "An Intrusion of Muscovite-Biotite Gneiss in the South-Eastern Highlands of Scotland, and its accompanying Thermometamorphism."

Royal Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. First Spring Exhibition.

Entomological, 11, Chandos-street, W., 7 p.m.

Royal Society of Literature, 21, Delahay-street, S.W. 1 p.m.

Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS), Annual Conference. 12 noon. 1. Presidential Address. 2. Rear-Admiral S. Long, "The Present Position of the Cruiser in Warfare." 3. Mr. W. Hök, "Approximate Curves of Stability."

THURSDAY, MARCH 23 ... Naval Architects (at the Ho OF THE SOCIETY OF ARTS), 12 a.m. 1. Dr. F. El "Some Considerations relating to the Strengt Bulk-heads." 2. Mr. George A. Calvert, " the Measurement of Wake Currents." 3. Cap E. E. Goulaeff, "The new Afonasieff's Form for Solving approximately various Problems nected with the Propulsion of Ships." 7 p.m. Mr. A. J. Durston, "Some Experiments on Transmission of Heat through Tube-plates." Mr. J. T. Milton, "Some Notes on the Testin Boilers."

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. Ann Meeting.

Royal Institution, Albemarle - street, W., 3 Rev. Augustus Jessopp, "The Great Revival Study in Mediæval History."

Electrical Engineers, 25, Great George-street, S. 8 p.m. 1. Sir David Solomons, "A New For Portable Photometer." 2. Mr. E. O. Wal "Earth Currents in India." 3. Mr. C. K. Falk stein, "Notes on the Influence of Electricity Tanning Operations."

Camera Club, Charing-cross-road, W.C., 8 Mr. T. C. Hepworth, "The Use of Photogra in Newspaper Work."

FRIDAY, MARCH 24...Naval Architects (at the HOUSE of SOCIETY OF ARTS), 12 a.m. 1. Herr E. Otto Schl "An Apparatus for Measuring and Registe the Vibrations of Steamers." 2. Capt. I. Kid "The Repairs of Injuries to the Hulls of Ves by Collisions, Stranding, and Explosions." 7 1. John Inglis, "Some Experiments with Engines of the S.S. *Iveagh*." 2. F. Edwa "The Cyclogram, or Clock-face Diagram, of Sequence of Pressures in Multi-cylinder Engine

United Service Institute, Whitehall-yard, 3 Capt. J. E. W. Headlam, "The Best Type Field Gun for the British Land Service, includ the question of Q.F. Guns."

Royal Institution, Albemarle-street, W., 8 Weekly Meeting, 9 p.m. Lord Rayleigh, "Int ference Bands and their Applications."

Civil Engineers, 25, Great George-st., S.W., p.m. (Students' Meeting.) Mr. Francis G. Ba "Some Points in the Regulation of Direct-curr Motors."

Sanitary Institute, 74A, Margaret-street, W., 8 p Prof. A. Wynter Blyth, "Sanitary Law: Engli Scotch, and Irish; General Enactments; Pu Health Act, &c."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science Schools, South Kensington, S. 5 p.m. 1. Mr. Thomas H. Blakesley, " Differential Equation of Electrical Flow." Prof. Perry, Mr. J. Graham, and Mr. L. Heath, "Experiments on the Viscosity of Liquid

SATURDAY, MARCH 25...Botanic, Inner Circle, Regent park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 P Lord Rayleigh, "Sound and Vibration."

The Telegraphic Address of the Society of Ar and of the Royal Commission for the Chica Exhibition, is "Praxiteles, London."

ournal of the Society of Arts.

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FRIDAY, MARCH 24, 1893.

ll communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday afternoon, March 20th, Prof. W. handler Roberts-Austen, C.B., F.R.S., livered the third lecture of his course on Alloys."

Professor Roberts-Austen will deliver a urth lecture on Monday, March 27th.

The lectures will be printed in the *Journal* ring the summer recess.

OREIGN & COLONIAL SECTION.

On Tuesday evening, March 21st, Mr. Cecil ane read a paper on "Newfoundland." Sir iarles Tupper, Bart., G.C.M.G., presided. The paper and discussion will be printed in e *Journal* of April 7th.

Proceedings of the Society.

FTEENTH ORDINARY MEETING.

Wednesday, March 22, 1893; Sir George ayter Chubb, Member of the Council, in e chair.

The following candidates were proposed for ction as members of the Society:—

ff, J. Clement, Singapore.
rn, Thomas L., Fernbank, Little Heath, Old Charlton, Kent.
ckintosh, Donald James, M.B., Western Infirmary, Glasgow.
nk, J. Henry, 5, Buckingham-gate, S.W.
witt, William Thomas, Post and Telegraph-offices, Madras.
rsey, Perry F., 161, Fleet-street, E.C.
imidt, Frederick Thomas, 9, Clarendon-street, Bradford.
ith, Watson, 34, Upper-park-road, Haverstock-ill, N.W.
er, Captain Henry Edward, R.E., 11, Craigorne-oad, Blackheath.

The following candidates were balloted for and duly elected members of the Society:—

Hounsom, William A., New Church-road, Brighton, Sussex.
Parsons, Frederick, Newport, Monmouth.

The paper read was—

THE MANUFACTURE OF NON-POISONOUS WHITE-LEAD.

By Perry F. Nursey.

Past-President of the Society of Engineers.

Introduction.—The White-lead Evil.

I desire this evening to enlist your sympathies on behalf of a class of workers in one of our most important and extensive, and, at the same time, most unhealthy industries, namely, the manufacture of white-lead. The pitiable condition of these workers is but little known beyond the immediate districts in which they follow their deadly occupation. I am satisfied you will give me your sympathies when I state that I ask them mainly on the behalf of girls and women who, as a rule, take up this baneful work when they are unable to obtain any other employment; and they take it up, too, with their eyes open, and with the knowledge that they are placing themselves face to face with disease and death. It would appear in some cases to be with them the alternative between death from starvation and death from disease contracted in earning their daily bread. That this is no overdrawn sensational picture you will all admit, before I have proceeded very much further. Most of you have heard of lead-poisoning, and perhaps some of you know by experience, either directly or indirectly, what it is. Few of you, however, are aware of the extent or nature of its ravages in white-lead works—white cemeteries they are called in Newcastle. Not that we need go to Newcastle for experiences, for we have them in our midst here in London. White-lead workers are almost entirely drawn from the ranks of women and girls of the poorest class. Skilled labour not being required, women and girls suit the purpose of the manufacturers, who only need someone sufficiently strong in physique and in nerves to carry a weight on the head and climb a ladder. And here I will close this chapter of horrors, but if anyone should desire to pursue the subject further, he will find in the *Daily Chronicle* of December 15 and 21, 1892, some trenchant articles upon the present subject, which embody authenticated statements which cannot fail to startle the reader, while they will

probably fill him with horror. Nor was the writer of those articles the first to attack the white-lead evil. Charles Dickens long since, in his "Uncommercial Traveller," laid his hand heavily, yet truthfully, on this life-destroying occupation, showing how the workers undertake it with the moral certainty of having to exchange it, after a few years, for the hospital or the grave.

But it is not only on behalf of those who make white-lead that I ask your sympathy, but also in the interests of thousands of others who use it. The fact is that it leaves its mark more or less wherever it goes, and its path is a very broad one, for the use of white-lead enters largely into many industrial processes, and is general as regards paint-making and painting. In these respects it is productive of what is known as painters' colic, painters' paralysis, and other diseases.

Ameliorative Measures.

The unhealthy nature of the white-lead makers' calling has long been recognised, and spasmodic efforts have been made from time to time to ameliorate the condition of lead-workers. Ten years since several Boards of Guardians directed the attention of the Home Office to the frequency with which cases of lead-poisoning occurred. The Shoreditch Union led the way, and Poplar, Holborn, Gateshead, Newcastle, Cardiff, and other Boards also took action. Shoreditch reported twenty-three cases of lead-poisoning during eighteen months, and Poplar thirty during twelve months, while at Holborn no fewer than fifty-four cases were admitted to the infirmary. The medical attendant at one white-lead factory reported that sixty-four cases of lead-poisoning had been referred to him in nine months, while at another there were 134 cases between May, 1881, and October, 1882. In consequence of these representations, Mr. Redgrave, the Chief Inspector of Factories, drew up a special report on the whole subject, and this was followed in 1883 by Sir William Harcourt's White-Lead Act, by which provision was made for the protection of the operatives by the introduction of certain details of dress and sanitary arrangements. The Act was well intended, but in view of the magnitude and deadly nature of the evil, has been found to be miserably inadequate. These troubles have also led to numerous attempts to modify the process, some of which have proved successful in ameliorating the evil to a limited extent. The fact, however, remains that this extensive and necessary industry is mainly carried o according to the old Dutch process of stack ing, which annually claims a very larg number of victims.

And here, perhaps, I may explain that th reason why white-lead made on the Dutc system is so deleterious is, that it is in th form of a white carbonate, which is highl poisonous. In the form of a sulphate, how ever, it is practically innocuous. Althoug the carbonate is regarded as an insolub salt—being less soluble in some waters tha even pure lead—it is readily acted upon an dissolved by the animal and vegetable acid of the food during digestion. On the othe hand, white-lead, in the form of a sulphate, much less easily decomposed, being capab of resisting the chemical change in th stomach, so as to render it absolutely no poisonous. As a matter of fact, in cases lead-poisoning, dilute sulphuric acid administered, by means of which the solubl carbonate becomes converted into an insolubl sulphate. The White-Lead Act of 1883 pr scribed acidulated drinks, as a means of r solving the carbonate of lead that had bee swallowed into a harmless sulphate.

The Dutch or Stack Process.

I have said that attempts have been mad to modify the ordinary process of carbona manufacture, and these have for the most pa aimed at reducing the time occupied in t production of the white-lead, and in so co ducting the manufacture that the lead had n to be handled at dangerous stages, and th the operations involving danger were carri out in such a way that the poisonous ator were prevented from finding their way into t atmosphere. Some of these improved pr cesses have been inspected by me, and purpose describing them as marking the ste of progress. Before doing so, however, I w give a brief outline of the Dutch or stack pr cess, which is carried out on the same ma principles in all lead works save in respect a few matters of minor detail. In this proce lead ore is first converted into pig-lead, a the pigs are then melted and moulded in small perforated thin cakes, which are plac in stacks and submitted to the action of acet acid, carbonic acid, and air. These stac are built up in the following way:—First a laid rows of small earthenware pots filled wi acetic acid; on these are piled the lead cake then a layer of tan, and then one of de planks. The women and girls who carry

ıis work continue these layers of acid, lead, ın and planks, until a height of 30 feet is eached. The tan begins to ferment, and the cetic acid, volatilised by the heat, acts on ıe surface of the lead, which in about four ıonths is reduced to a carbonate, so that hen the women enter the stack to remove it, ıey find a core of blue lead with a crust of hite material adhering, and this is white-lead ı the rough. These beds simply breathe out oison, and the women cannot avoid the dust ettling on their persons and their clothes. It lings to their skin, it gets in their hair, and ı spite of overalls, respirators, and other conivances, it finds its way into their systems, ı due time effecting its insidious work, and eading, sooner or later, to consequences more r less fatal. After removal from the stacks, ıe white-lead is ground in water and finished ı drying stoves, these operations adding bout three weeks more to the protracted eriod of manufacture.

From my youth up I have been taught ıat—

> "For every evil under the sun
> There is a remedy or there's none;
> If there is one, try and find it,
> If there's not one—never mind it."

There are no remedies for storms and tempests, and other convulsions of nature, nor ave we yet discovered the art of bottling down olcanoes. But for the white-lead evil there a remedy, and we will now try and find it.

Thuard's Process.

The first idea of a remedy appears to have een the quickening of the process of production. Going back to the end of the last entury, we find M. Thuard, a French chemist, emonstrating that when a basic solution of a ılt of lead, produced from lithal, was subitted to the action of carbonic acid gas, a ırbonate of lead was precipitated. The whitead was produced in a few hours, and the rocess admitted of being carried on connuously at little cost. This has been the asis of many of the improvements since made the production of precipitated lead. At rst this method was thought to meet all quirements, but it soon became evident that ıe quality of the lead was inferior, and it was ıown that white-lead so made was, as comared with stack-lead, of far less specific ravity. Chemical analysis showed it to ffer considerably, and that the particles of hich it was composed were semi-transparent ystalline, whilst those of stack lead are amorphous and opaque, and, consequently, it did not cover well as a paint. The advantages of the precipitation process, however, were admitted to be so great in point of time and economy that attempts have continually been made to remedy these defects, and to make the quality of precipitated lead equal to that made by the stack process, but, hitherto, without success.

The Martin Process.

The first pronounced departure from the conventional method examined by me was the Martin process, which was started on a working scale in 1880, at a large factory in Ossory-road, Old Kent-road, London. At the time of my visit to these works, in 1881, pig-lead was first melted, and run through a series of small spouts into a revolving cylinder, the lead cooling in the form of flat spots, or "splashes," as they were termed. The splashes were delivered into a series of trays, and over them was pumped, through travelling spouts, a weak solution of acetic acid. The product was acetate of lead, which was further treated for white-lead. The use of metallic lead, however, has been discontinued, and in its place oxide of lead, or litharge is now used, the remainder of the process being unaltered. The litharge is dissolved in a solution of acetic acid, the product being acetate of lead, which, as fast as it is formed, is pumped into vats, where carbonic acid gas is forced through it. By this means, a precipitated carbonate of lead is formed, which is pumped into a series of filter presses, where the lead is separated from the liquor and retained in the filter bags. The white-lead, which has now assumed the consistency of clay, is removed from the filter presses by the workmen with special knives. Up to this time, the lead has been moved about by the aid of machinery, and, although manual labour now becomes necessary, the workmen do not touch the white-lead, which is removed on trays to a vertical pugging-mill, where it is treated with pure water, to wash out all the acid. From the vertical mill the lead solution flows, after a given time, to a horizontal pug-mill, where the last traces of acid are washed from it, and it is allowed to settle. The lead is then pumped into a second set of filter-presses, where it is finally filtered for drying. Up to a certain point in the process, the lead thus made is deficient in body or covering property, but this is imparted to it at one of the stages by the addition of a solution of lead in a particular

chemical form, which gives it the desired body, and renders the process perfect.

From the second series of filter-presses, the white-lead, which has again assumed a clayey consistency, is removed on trays to the drying apparatus. It is there fed into a hopper, whence it falls through a pair of revolving rollers on to an endless travelling canvas band passing over a long series of steam-heated cylinders. At the end of the journey it has parted with nearly all its moisture, only about 8 or 9 per cent. remaining in it, sufficient, however, to prevent any dust being formed. It is then delivered into a closed and steam-heated tunnel, in which an Archimedean screw or creeper conveys it to a grinding-mill, where it arrives quite dry. It is now ground under a pair of edge runners, and discharged at intervals into barrels, ready for the market, the whole of the operations being conducted without any dust creeping into the air, as the mill is enclosed, and the discharging arrangements such that the fine particles are precluded from finding their way into the outer atmosphere. It will thus be seen that from first to last, although a carbonate of lead is produced, the elements of danger from contact or inhalation are carefully, and I believe successfully, guarded against, and that in this important respect the process is one which entirely meets the requirements of humanity. At the same time, a good article appears to have been produced in a few hours instead of many weeks. From recent inquiries I find that these works have been temporarily stopped.

The Lewis-Bartlett Process.

The next system which came under my personal notice was the Lewis-Bartlett process, which is noteworthy for containing in one, two previously distinct manufactures, namely, the production of pig-lead and white-lead. The ore is volatilised by heat combined with a current of air, by which the lead fumes are carried forward and ultimately condensed or solidified, instead of being discharged into the air, the final result being a sublimed white-lead of very fine consistency and good covering property. The system was introduced into this country from the United States by Messrs. John Hall and Sons, of Bristol, and was carried out by the Bristol Sublimed Lead Company, at their works at Avonmouth, where I inspected the process in 1886. The dressed ore is delivered on the works from the mines, and is first fed into a furnace of the double Scotch hearth type, known as the "Jumbo." The ore is mixed with a small proportion of slack, to maintain combustion, and a small dose o lime is occasionally added. The blast is supplied by a blower, and, as the ore is smelted the molten lead runs into a basin in th hearth and flows over into a receiver, from whence it is cast into pigs. As the slag is removed from the furnace, it is passed on fo further treatment in another furnace, where we shall presently rejoin it. The products o combustion, under the name of "fume," are drawn from a furnace through a tube by a fan Passing through the fan, the fume is drive forward through another tube to the bag-room This room has a floor formed of iron plates, i which is a series of circular holes, each abou 2 feet in diameter. Over each of these opening is a coarse woollen bag, 30 feet long, of th same diameter as the opening, and suspende from the roof by its upper end. About thre feet below this floor is a series of iron hopper opening into the room below. The fume under pressure, enters the space between th tops of the hoppers and the underside of th bag floor, and is forced up the bags. Th flue-dust collects inside them, but the sulphur ous vapours find their way out through th bags into the room by percolation. When sufficient quantity of lead has accumulated the blast is shut off, and the sublimed lead, c "blue fume" as it is called, falls into th hoppers and is run out thence on the floo below. We have now a light fine powder of bluish tinge, some of which is used for makin lead-coloured lead paint. The bulk, howeve undergoes further treatment for the productio of the ultimate result—namely, pure white lead.

I must now take you back to the smelting house, where there is a second furnace, know as a slag-eye furnace. Thither the slag fro the "Jumbo," and the blue fume are brough mixed together, and fed into this furnac The blue fume falls from the hoppers in light powdery condition, the removal of whic in this state would involve danger to the wor men. Before it is removed to the slag-ey furnace, however, a shovelful of live coal thrown on to it at one end of the floor, ar this fires it. By a process of slow combustic it is converted, without detriment, from a lig powder into a compact friable mass of yellowish colour, which is easily dug o and loaded into barrows. The mixtu of blue fume and slag is fed into t slag-eye furnace, from which a small quanti of metallic lead is here produced, tl

ag running off in a molten state as formed, nd the fume being drawn off by a fan and ›rced onwards through two settling towers nd a series of bent pipes, known as "goose-ecks" to a second bag-room. This room is imilarly constructed to the first one, and the ıme is driven into the bags in the same way, nd when the blast is shut off, the solid par-cles fall into the hoppers. They are with-rawn thence through traps into receptacles elow in the form of sulphate of lead. I can-ot say whether or not these works are still in peration, not having received any reply to my etter of inquiry on the subject, although I ave been informed that the process is not now eing worked.

The MacIvor Process.

A few years since Professor Emerson IacIvor made the discovery that litharge, or xide of lead, was soluble in a certain alkaline olution, which hydrated the lead, and that, hen in this condition, the hydrate combined ith carbonic acid gas and formed white lead, r a true basic carbonic of lead, liberating the lkaline solution, which was recovered to ttack fresh charges of litharge. This prin-iple was developed into practical form at ome experimental work in the Clapham-road, ondon, which I visited in 1890. In this pro-ess the litharge is first prepared from lead re, and is thoroughly purified by washing. charge of the pure litharge is then put into closed vat, in which are revolving stirrers, nd a solution of acetate of ammonia is added it. This mixture is agitated for six hours, t the end of which time the lead will have een wholly absorbed into the ammonia solu-ion. It is then allowed to settle, and the upernatant liquor containing the lead is umped over into a second vat, similarly con-tructed to the first one. In the second vat he solution is submitted to the action of arbonic acid gas, when the pure white-lead is recipitated from the acetate of ammonia, hich is thus recovered, and is ready for use gain. The mother liquor is run off, and the hite-lead is passed through filter-presses, to eprive it entirely of the mother liquor. The ressed lead then goes to the washing pparatus, where it is agitated for a time in a ath of cold water, and is then allowed to ettle when the water is drawn off. This pro-ess is repeated eight times, when the white-ead is found to be sufficiently washed. It is hen again passed through filter-presses, and s finally submitted to hydraulic pressure, in order to extract all the moisture capable of removal by mechanical means. From the hydraulic presses the white-lead, which is a carbonate, is taken to the drying-room, where it is dried at a temperature of from 160° to 180° Fahr., when it is ready for use. It is claimed that by this ammonia process white-lead can be produced at a cost below that of the pure lead required to make stack-lead, and that it can be made in six hours as against four months by the old system. A further point is that all the operations are carried out in the wet way, so that there is no dust, and less danger to health.

The Improved MacIvor Process.

In the course of developing this process into practical form, it was found that it did not contain all the elements of success. It was, however, improved by Dr. MacIvor, in conjunction with Professor Watson Smith and Mr. William Elmore; and a factory was built at Northfleet, Kent, for working the process on a commercial scale. I visited these works in 1891, before they were in full operation, but only saw the white-lead produced by means of model apparatus on a large scale. In dealing with a volatile agent like ammonia, it is imperative that the chemical engineering be of a perfect kind, so as to secure as little loss as possible, and this was one of the features of the improved MacIvor process. The original process had been improved in such a manner, that even from very inferior grades of litharge it was stated that a chemically pure white-lead is produced. It is, moreover, so produced, that not only is the acetate of ammonia used continually returned—*i.e.*, kept in circulation —with but a small per-centage of loss, but, from the entrance of the litharge into the digesters to the exit of the finished product ready for drying, the whole process is conducted in closed apparatus, and the work goes on automatically. In reply to recent inquiries, I am informed that the process has since been worked on a commercial scale, although the output has not been a large one. Pending the reconstruction of the company owning the patents, the factory is at a standstill.

Freeman's Innocuous White-Lead.

The white-lead evil has also been dealt with in a practical manner by two other manufacturers, with whom I have communicated in order to obtain particulars of their special methods of manufacture, so that my paper might be as complete as possible. In one

instance I have been requested not to refer to the manufacture, and I, of course, respect the wishes of the parties. In the second case I did not experience such reticence, and particulars of the process were sent me. This is Freeman's "innocuous white-lead" process, which is carried out at works in Hatcham-road, Old Kent-road, London, which works I have not had the opportunity of inspecting. It is hardly necessary for me to state that Messrs. Freeman are amongst the oldest white-lead manufacturers, and they have been fully alive to the evils incidental to the stack system. In their process the molten pig-lead is poured through a machine, which quickly transforms it into small flakes, on an inclined plane, up which it is carried and thrown off. The lead is then collected and placed in vats, which are specially constructed to produce rapid oxidation of the metal. An acetic acid solution is then introduced to the mass; and for every five tons of lead so treated sufficient is carried down, in the form of a liquid, each time it is drawn off, to produce 900 lbs. of lead. Sulphuric acid is then introduced into the liquor, when the sulphate of lead is deposited as a white precipitate. This is taken out and washed with water, and deposited in vats. When these vats are nearly full, they are emptied of the sulphate of lead, which is of the consistency of a thick paste. It is then dried in the usual way, and to it is added a certain proportion of oxide of zinc. It is then submitted to special treatment, whereby a complete change is said to be effected in its properties, a body and density much in excess of that of the ordinary white-lead being imparted to it. It is stated that the compound before treatment weighs only 112 lbs. per cubic foot, but that after treatment it weighs over 200 lbs. per cubic foot. Its colour is said to be whiter than that of any other lead, which is probably due to the zinc, and it is said to be highly approved of by users. It will be seen, however, that whatever its excellences—and I do not for one moment question them—this is a compound of sulphate of lead and zinc.

The Non-poisonous Process.

I now come to the latest process of which I have a personal knowledge, and which I had the gratification of inspecting in operation in January last. This is a sublimation process, which has been for some time past carried out on a commercial scale at the Caledonia Works, Possil-park, near Glasgow, which belongs to the White-lead Company, Limited. The theory of the process is based upon the rapi[d] oxidation of the galena, which is a sulphide into sulphate of lead, and its subsequent con[-]densation, washing and drying, and it i[s] carried out by the aid of a plant consistin[g] of a number of subliming furnaces and acce[s]sories. Each furnace measures, internall[y] about 3 feet 6 inches by 4 feet deep, and th[e] fumes pass through a narrow outlet into [a] combustion chamber beyond. The furnace[s] are connected up in groups of six, with a mai[n] flue leading to a tower and special condensin[g] apparatus. The sulphate of lead is mad[e] direct from the dressed ore, which is receive[d] at the works from the mines in a conditio[n] for the most part, sufficiently fine for sub[-]liming without having to be ground. Th[e] bulk is, therefore, simply riddled, and th[e] larger portions ground. In starting a set [of] furnaces, they are lighted over night, an[d] are in good order for charging early in th[e] morning. The coke bed is brought up near[ly] on a level with the upper sill of the furnac[e] door, and the ore is then distributed over i[ts] surface in quantities not exceeding two [or] three shovelfulls at a time, the efficacy of th[e] process being dependent upon the rapid volat[i]lisation and resultant oxidation of the ore. Thi[s] operation is conducted so successfully, tha[t] I am informed, 108 per cent. of the entir[e] charge is converted into its equivalent of white lead. The proportions used in actual practic[e] are one ton of galena to under one ton of coke the latter containing about 5 per cent. of ash The action in the first chamber consists in th[e] oxidation of coke or carbon, mainly into car[-]bonic oxide, and the rapid volatilisation of th[e] sulphide of lead, which compounds, on enter[-]ing the second, or oxidising portion of th[e] furnace, are converted respectively into car[-]bonic acid and sulphate of lead. During th[e] charging, no ore is thrown on until the pre[-]vious charge has disappeared, as otherwis[e] the fire tends to get choked and to lose i[ts] heat.

The fume passes from the furnace to th[e] furnace flue, where it meets a blast of air in[-]tended to complete the oxidation of an[y] volatilised galena or coke-dust. At the end [of] the main flue the gases are conducted throug[h] a tower about 20 feet high, into iron flues [...] feet in diameter, terminating in an iron bo[x] containing two steam injectors, by which th[e] gases are forced into the condensers, in whic[h] there are three compartments, and in whic[h] the gases are absorbed into water. Each con[-]denser is constructed of wood, and is line[d]

h fire-brick in order to resist the heat. The ıe, now mixed with steam, is forced under : flies, and gains the second box of the con- ıser through a brick channel. In this box : flies are bricks with vertical openings, ough which the fume is forced, a portion ing condensed. In the second box the heat not so great as in the first, and the wooden lls are simply lined with sheet brass. From : second box the fume reaches the third and ;t, which contains wooden flies, with a ıch narrower aperture than those in boxes ınd 2. The waste gases are conducted into downcast, communicating with a stack 175 :t high. In order to compensate for evapora- n, the condenser is fitted with a cistern and ll-cock, so as to secure a continuous flow of .ter. The contents of the three boxes are ;charged into the washing vats at suitable ervals, and are then thoroughly washed with ghtly acid water, to convert any oxide into phate. The product is then further washed, free it entirely from acid and impurities, and :n, after settling, the white-lead in the form sludge is pumped over into the filter-presses, d subjected to a pressure of 90 lb. per square :h. In these presses most of the water is t rid of, the product when removed from the :ss bags being pure sulphate of lead con- ning from 10 to 15 per cent. of water. This then placed in earthenware pans in the ying-rooms by women and girls, and dried a temperature of about 120° Fahr.; and er this operation, the lead is taken into the cking-shop, where it is packed in barrels for : market. I may mention that in addition to : foregoing treatment a method of mixing : sulphate with a hydrated oxide of lead has en adopted so as to render the product equal the best pigments for use in the trade. The ıd is also worked up with oil, and sent out white-lead in oil; it is likewise made into ;ments of various colours, and sent out in ses ready for painters' use.

It will be seen that the reduction of the time manufacture has in this process reached the vest possible limit, inasmuch as the pro- ction of the white-lead sulphate in the first ıge is a matter of minutes as against onths in the stack process. The new ocess, moreover, is eminently practical and nple and does not involve the use of in- cate or expensive machinery or apparatus. ; regards the quality of the white-lead pro- ced, there appears to be a consensus of inion among many who have used it, as to uniformity and superiority as regards colour, covering power, and permanence. I have seen a number of testimonials from well-known companies and firms who have used it, and who all write of it in the most satisfactory terms. It is also found to answer well as a paste for paper stainers, for which purpose it has double the covering power of carbonate, or any other white pigment. It is also successfully employed as a distemper.

But however rapidly and cheaply the new white-lead may be produced, however simple the process, and however excellent the product, all these recommendations must go for nothing, from a humanitarian point of view, if its manufacture and use were not innocuous, and unattended by danger to health and life. In other words, the sole recommendation of the process and the product, from the point of view I am taking, is that they practically secure immunity from a scourge, the character of which I have sufficiently indicated in my opening remarks. So far, however, you have only my word for its innocuous character, and I cannot pretend to speak with absolute authority on this point. One thing, however, I may say in support of my convictions, and that is that the operatives at Possil-park—men, women, and girls—presesented a healthy appearance, nor could I, from inquiry amongst them, elicit an unfavourable opinion of the manufacture. This, you may urge, is little better than negative evidence. But I took care to obtain positive evidence upon the subject, for I inquired of Dr. Muir, the medical officer to the works, openly, and before a number of gentlemen who were present, as to the general sanitary condition of the workers. That gentleman stated, that during his four years' experience of the process, he had not met with a case of illness which he could trace to the manufacture of this sulphate of lead; whilst he considered the possibility of lead poisoning amongst the workpeople to be most remote. Beyond this, there is the independent testimony of Dr. Farr, late Officer of Health for Lambeth, who has inspected and reported upon the works from a sanitary point of view. He expresses himself as being satisfied with the safety, as regards health, of those engaged in the manufacture of this sulphate of lead, as well as those who have to use it. He says in his report:—"If a physician were called upon to attend a case of lead-poisoning by carbonate, he would administer sulphuric acid, in order to convert it into a sulphate or insoluble form of lead. It is obvious that the white sulphate of lead, therefore, carries with

it, so to speak, the antidote to the poison. On humanitarian grounds alone, it should command the serious attention of the Local Governmont Board and the Board of Trade, and its use should be insisted on."

Conclusion.

I have taken you back a century to the earliest improvements in white-lead manufacture, beginning with Thuard in 1790, and, passing over the intervening space, have traversed the last decade, ending with the White-lead Company, Limited, in 1893. I do not pretend to have brought under your notice every detail of improvement, nor every process that may have been proposed or even adopted. With the exceptions stated, I have confined myself to matters within my own knowledge and observation, which, however, I trust will be found to convey sufficient information for the present purpose. My object is to expose a plague-spot in British industries, and to point out a remedy. From what I have stated it will be seen that much time, thought, and money have been expended by inventors and manufacturers in their endeavours to cope with the white-lead evil. In this there has been some success. The fact, however, remains that the protection afforded by the improved processes only affects the workers in a moderate degree, and the users and the public not at all, inasmuch as for the most part the poisonous carbonate is produced. The one exception appears to be the production of a harmless sulphate in the place of a poisonous carbonate, and it would seem that, according to the latest improvements, all the properties which have for so many years made the carbonate valuable can now be produced, even in a higher degree, in the sulphate, and this affords protection to all who make it and all who use it. For these reasons, I consider that, in its results, the Possil-park process is a decided advance upon the others which I have examined. I, moreover, consider it equally an advance in itself, inasmuch as it is simple, direct, and rapid, and, so far as my observation goes, economical.

But, whilst inventors and manufacturers have been seeking to solve the problem, there have not been wanting those who, upon humanitarian grounds, have endeavoured to ameliorate the lead-workers' hard lot, by compelling the introduction of precautionary measures. These measures are, however, at the best, insufficient to stay the ravages of disease and death; for, notwithstanding the development of improved processes of manu facture, the bulk of the white-lead now mad is still produced by the stack process, with i attendant troubles. But public attention h once more been directed to the matter, and appears likely to receive the attention Parliament during the present Session. C the 17th of February last, Mr. Swift MacNei in the House of Commons, drew the attentic of the Home Secretary to the question, ar asked him what steps the Government intend to take to investigate, and, if possible, preve the loss of life in white-lead factories. M Asquith said that the matter had for son time engaged his attention, and that with tl co-operation of the Board of Trade, he h arranged for the institution of an exhausti inquiry into the case, both in its industrial ar its sanitary aspects.

So far this is encouraging, and it is in r spect of this proposed inquiry that I ask tl active sympathies of all who can assist in pr moting this philanthropic object. A thoroug investigation will disclose the fact that tl white-lead industry lays a heavy burthen disease and suffering upon the bulk of tl workpeople engaged in it. Such a revelati should oblige the Government to adopt measur for superseding the ordinary stack process one or other of the systems I have describe provided no better offers when the time f action arrives. I have already stated which consider to be the best system at present d veloped, and as I have no interest whatever that or in any other white-lead process, a opinion I may express may be considered disinterested and impartial. But whichev process may be selected, it should be, a doubtless will be, that which is calculated confer the greatest benefit on the large number.

DISCUSSION.

The Chairman congratulated the reader of paper upon the very clear way in which the subject h been put before the meeting. He thought they co come to the conclusion that, besides the old proce there was but one practical process in connection w the manufacture of white-lead. Though not preten ing to any particular knowledge on this subject beyo that which he had gathered from ordinary a scientific papers, as a manufacturer interested in welfare of all workers in factories, he thought, wh ever they might think of the details of the paper was clear that there was a real evil which needed be remedied. Mr. Nursey mentioned that the Ho Secretary had promised an inquiry into the matt

l perhaps, in reply, he would tell them whether inquiry (which, he presumed, would he conducted the Home Office and the Board of Trade) was ng on, and when there was likely to be a report. It s not necessary to go into the commercial details of ne of the processes mentioned, because they were in use; but as to the non-poisonous process, it ght be of use to know how the selling price npared with the selling price of ordinary white-d. He should also like to know what the average ges paid to the women and girls in this trade re.

Mr. J. B. HANNAY compared Mr. Nursey's paper the play of "Hamlet," with the Prince of Denmark t out, because his (Mr. Hannay's) process was scribed, but his name omitted. He was rather ased at this, because he wished to entirely udiate the action of the company whose works r. Nursey visited. In consequence of the manner which his (Mr. Hannay's) process had been worked, ery ton of white-lead the company made was loss to the shareholders. He had prepared a aper on the manufacture of white-lead; and he ped, by model apparatus, to show the proper ay. They would then see whether Mr. Nursey's scription of the process was accurate. Further, he sired to say that his process had not been properly rried out at Possil-park.

Mr. R. H. HARLAND said that Mr. Nursey had de-ribed in a concise form all the processes and patents ken out for many years. He must take exception to lling sulphate of lead white-lead. As a chemist, he id that statement was erroneous. White-lead mbines with the linseed oil, and forms a chemical mpound; but in the case of sulphate of lead no ch compound occurs; it is simply a mixture of nseed oil with sulphate of lead, which, when painted n the surface, acts in the same way as whitewash n a wall. That was known to every painter.

Mr. HANNAY said that the old idea held by the anufacturers, that ordinary white-lead saponified e oil, was erroneous, as when the white-lead ground n oil was thoroughly boiled and washed with ether very trace of oil was extracted, leaving a perfectly ure carbonate, which dissolved without the slightest loudiness in dilute nitric acid. White-lead thus ixes entirely mechanically with the oil as do other rdinary colours.

Mr. HARLAND, continuing, stated that he had nalysed many hundreds of samples of white-lead, nd entirely dissented from Mr. Hannay's statement s to the non-saponification of Dutch white-lead with inseed oil. It was impossible with ether, or any other olvent known to chemists, to remove every trace of il, even if the extraction be continued for weeks, nd, he would almost venture to say, months. He went through the white-lead works of Newcastle, Glasgow, and several in London, and found the workpeople in most of them not as described by Mr. Nursey—in a dangerous condition and almost at the point of death—but healthy and well cared for by their employers in almost every way. Machinery had been introduced for drying white-lead without its being touched by the hand. The evil effects of manufacturing white-lead were considerably reduced by the Dutch process, and he thought that a Government inquiry would establish that that process was not harmful to the work-people in the way described by the lecturer.

Mr. HENRY J. DYER said that he was glad Mr. Nursey had brought this subject forward. In the interests of humanity it was a subject that should be dealt with. It was very important; for the health of the community was concerned. He had seen men who, when first engaged in this work, were hale and hearty, become, in the course of a month, heavy, dull, and sluggish, and almost invariably requiring medical treatment, as a consequence of handling and working the lead made by the Dutch process. Amongst house-painters and others, who were obliged to use this lead, he had seen much suffering —such as colic, wrist-dropping, and other incidental ailments. He was surprised that Mr. Nursey had not mentioned Prof. Gardner's experiments for making white-lead by electricity, which, though it produced the ordinary poisonous lead, had the advantage of reducing its manipulation to a minimum. He had met with and had had some considerable experience with Freeman's innocuous white-lead which seemed to be absolutely free from all the objections incidental to the poisonous white-lead, the only one being, so far as the house-painter was concerned, that it requited a little different treatment. The house painter being accustomed to the use of the poisonous lead, preferred it to using anything else involving a little extra trouble, even though his health be concerned.

Mr. G. HOWE asked whether saponification took place with the new method as with the old Dutch process, and whether the covering qualities of the non-poisonous white-lead were as good as the genuine white-lead of the past.

Sir H. TYLER said that, as chairman of the company now working the non-poisonous white-lead at the Possil-park Works at Glasgow, he was able to answer the question of the last speaker in the affirmative. He had a certificate from a painter, paperhanger, and decorator, of Hull, to the effect that the non-poisonous white-lead covered equal to two coats of the ordinary lead, and was 3s. per cwt. cheaper. Non-poisonous white-lead was not the white-lead of the past, but perhaps it might be the lead of the future. He could inform Mr. Hannay of improvements in the furnaces he had handed to them.

Prof. C. Le Neve Foster, F.R.S., said that he came to the meeting in the hope that British lead mines might derive some benefit from the non-poisonous process. He should like to ask Mr. Nursey whether the plant was sufficiently inexpensive for large mines to put it up, and manufacture white-lead upon the spot. It had been asked whether this new compound would form a lead soap in the way that the present white-lead did. The paper itself seemed to answer that question, for Mr. Nursey said that the hydrated oxide of lead was mixed with the sulphate, he (Professor Foster) presumed with the object of producing a lead soap when this new white-lead was mixed with oil. He thought it hardly correct to say that the new process and the old Dutch process were the only methods at present in use for manufacturing white-lead on a commercial scale, because, when travelling in Germany two years ago, he found works at which he was informed white-lead was being produced by a precipitation process, the natural carbonic acid gas given off from the earth being used as a precipitant. With every wish to make the trade as little noxious as possible to the workman, one must recollect that the workman could do a great deal for himself by being careful. That fact had been brought home to the mining world, as the plumbism lately so rife at the Broken Hill Mines, New South Wales, was ascribed to the fact that workmen ate their food and put tobacco in their pipes with dirty hands, covered with powdery carbonate of lead deposit, with the result that, in eating and smoking, they took the poison into the system. Cleanliness would do a great deal for the workman, and the means of cleanliness ought to be provided by the employers. It should scarcely go before the world that this new white-lead was harmless, because it contained a proportion of oxide of lead. One would like to hear from the painters' own mouths how this new compound worked; and he regretted their absence.

Mr. W. F. Reid contended that the workpeople could not be protected against infection without a most rigid system of supervision. Anything that could be done to render carelessness on the part of workpeople impossible would be a great improvement, from a humanitarian point of view. He did not think this sulphate of lead would equal in permanency the old white-lead, for the reason that the change that went on in the oxidation of the linseed oil was the work of years.

Sir Henry Tyler, referring to the permanency of sulphate of lead, said that a ship which came in to be repaired, was, contrary to the ordinary way, sent out without being repainted, because the sulphate of lead had stood so well.

Mr. Nursey, in reply, said that he did not pose either as a lead manufacturer or as a chemist. The main reason for his coming there was to promot[e] movement which was taking place to put white-le[ad] manufacturing on a sounder and healthier basis. W[ith] regard to the Board of Trade inquiry, the committ[ee] had not been formed, but was in course of form[a]tion. Governments did not move very rapi[dly] sometimes, but he understood that Mr. Asquith [did] not intend to let the matter drop, inasmuch as [he] had previously had knowledge of the circumstanc[es] and expressed an interest in the subject. He h[ad] avoided mentioning prices, not thinking it desirable [to] arouse discussion between rival manufacturers; a[nd] not having gone into the wages question, he w[as] unable to give the Chairman the figures he h[ad] asked for. His belief was that this new paint h[ad] very excellent covering properties, but that must [be] determined by experiment. The plant was not [ex]pensive, but he imagined that the royalt[y] that would have to be paid would prevent [its] erection at mines. Mr. Reid had suggested th[at] the sulphate of lead was not equal to white-le[ad] as regarded permanency, but he did not think M[r.] Reid had tried the new white-lead sufficiently.

Mr. G. B. L. Whiteley mentioned that [in] London the standard wage for men engaged in t[he] production of white-lead was 27s. per week, and [for] women 13s. 6d. per week.

The Chairman proposed a vote of thanks [to] Mr. Nursey, which was carried unanimously.

Miscellaneous.

THE EAST INDIA COMPANY'S RECORD[S].

"The First Letter Book of the East India Co[m]pany, 1600-1619," is the title of a work j[ust] published by Mr. Bernard Quaritch. In his int[ro]duction, the editor, Sir George Birdwood, writes: "The official value of the volume consists in t[he] early date, and important character, of the doc[u]ments it contains. Over one-fourth of them are of t[he] first six years [1600 to 1606] of the existence of 'T[he] London East India Company,' commonly call[ed] 'The Old East India Company,' a period of whi[ch] the records have hitherto been extremely meag[re]. Exclusive of the 'Court Minutes,' there are o[nly] fifty-four original MSS. in the India Office belongi[ng] to the period, and of this number forty-eight [are] included in the present volume; while of a lar[ge] proportion of the one hundred and seventy-ei[ght] letters and commissions embraced in it, no oth[er] first-hand copies are known. The volume is especia[lly] serviceable in filling up the gap caused by the neve

-be-sufficiently-regretted loss of the 'Court Books' 'Court Minutes' for 1603-1606, and 1610-14, and thus sustaining the continuity of the contemporary ficial records for the first obscure years of the 'Facry Period' in the history of the East India Company, tending from the formation of the 'London' Comny in 1600 to its absorption in the 'English' Comny trading to the East Indies' in 1709." Sir George irdwood offers an explanation of the ornamentation of e work, the most important feature of which is the olophon. "This device originally marked the last ige of a book, and contained the place and year of publication, but was ultimately transferred, with ese particulars, to the title-page, where, chiefly rough want of sufficient space, the Colophon gradully dwindled to a mere trade-mark, of the baldest, d, too often, most disfigured kind. In the present lume, it has been replaced in its proper position at e end of the book, its central geometrical elements ily being repeated on the title-page; and here in eir consonant colours, on the very spot assigned in e highest usage to some personal badge, or to the ms of the writer or editor of a work. Whoever ay be author of a book, its finisher is, after all, the uch abused publisher, without whom it could not brought to its fateful issue; and as the word Colophon' is derived from the circumstance of e calvary of Colophon, one of the twelve cities of e Ionian league, having always been kept in reserve the allies to make the last charge and decide e battle [whence the Greek proverb, 'He put e Colophon to it,' τὸν Κολοφῶνα ἐπέθηκεν], it doubly appropriate, in etymology as in ritual, at the publisher's distinctive device should be printed at large on, or opposite to, the last page a book; and that, proportionately to its use and gnificance, the utmost art should be lavished on colophon, or 'finishing touch.' The printer and nder are also each entitled to their personal stamp, d should take a pride in contributing it, draughted the best designers of their time, to the concration of every book of good faith in the preiration of which they have had a helping hand." fter mentioning that, in this instance, the design is been adapted to the family history of Mr. uaritch, founder of the brotherhood of "the Sette Odd Volumes," Sir George Birdwood continues:- "The specific charm of Indian, as of all ancient siatic, art is that, whether in the vague amplitude the metaphorical descriptions of the theologised trology of the Revelation of St. John the Divine, the definite epitome of such traditionary decorave types as the 'knop and flower pattern,' and the one pattern,' it is everywhere the conscious reflecon of the whole universe of things seen and unseen, e sanctified cypher, as it were, of the visible eation of forces and phenomena, and of their insible, inscrutable Creator, the one God of all iman faith, and love, and adoration. Thus it has, om the earliest times, in the ultimate types of its etical and pictorial imagery, portrayed the cosmos as a virgin mother, a suffering and redeeming god-man, a holy mountain, a four-square heavenly city, and a garden enclosed, with its Paradisaical tree planted by the four-parted waters of eternal life. The first Paradise, and the first Tree of Life, were of direct physiological origination [compare κῆπος and 'hortus'], and the most obvious exponents of the generative and reproductive principles of nature; the second Paradise was geographical, and its characteristic tree was ever its worshipful Tree of Life, as the date palm in Chaldæa, and the ash tree of the Norse nations in 'Asgard' [the country about the Sea of Azov]; while the final, trascendental Paradise was the green earth itself, or, at least, its northern hemisphere, 'the mountain of the Lord,' rising above the 7 [or 9] hells of the southern hemisphere, and the final, consummate Tree of Life, the 7 [or 9] planets simulated as a date palm, or some other tree, deep-rooted in the earth, and carrying its 7- or 9-branched head into the highest heavens, and guarded by the mystical cherubim ['the Two Witnesses'], all encircled, or ensquared, by the twelve signs of the Zodiac, and their twenty-four deacons, the 'flammantia mœnia mundi.' It may be said that nearly all the traditional devices in decorative design are derived from this sublime Chaldæan presentment of the Tree of Life; and throughout their infinite permutations, they in Indian art retain, 'void of all prophanation,' their original sacramental significance, and still utter forth their hallowing voice of archaic praise: 'Alleluia! for the Lord God Omnipotent reigneth! Alleluia! Salvation, Glory, Honour, Power unto the Lord our God!' In the colophon designed for Mr. Quaritch, the earth is indicated by a circle divided through its horizontal diameter into the nether world of night and winter, destruction and death, and the upper world of day and summer, light, and life and glory; and the planetary tree by the Papal Cross, as the emblem of the historical continuity of the development of religious doctrine and ritual in the formulated Christianity of the Catholic Roman Church. The geometrical structure of the striking type thus obtained symbolises the creative forces of nature with the ingenuousness of the corresponding *lingam-yoni* symbol of the Hindus; and I have emphasised this in transferring a reduction of it to the title page, by colouring it red in its active, and blue in its passive element. The zodiac is conventionally denoted by the oak sprays, bearing between them 12 acorns and 24 leaves; and these sprays refer again to Mr. Quaritch personally." Sir G. Birdwood concludes as follows:— "When I began to edit the present volume, it was my intention to undertake the self-imposed task of editing all the Court Books of the 'Old' East India Company, following the volume published by Mr. Henry Stevens, down to 1623. But after sixty, every year adds rapidly to one's incapacity for the incessant labour of minute verification required for the proper discharge of so burdensome a duty. This has become painfully clear to me during the past

twelve months; and for the future it is my purpose to allow nothing to interfere with the advancement, and, I pray God, the completion, upon my last tide, of the long-delayed enlarged edition of my book on 'The Industrial Arts of India.'"

MEETINGS OF THE SOCIETY.

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

APRIL 6.—SIR EDWARD N. COVENTRY BRADDON, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo-Indian Colonisation." LORD BRASSEY, K.C.B., will preside. The paper will be illustrated by lantern slides.

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

APRIL 11.—PROF. PAUL SCHULZE, "History and Development of Pattern Designing in Textiles." THOMAS WARDLE will preside.

CANTOR LECTURES.

Monday afternoon, at Five o'clock:—

PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S., "Alloys." Four Lectures.

LECTURE IV.—MARCH 27.—Advances in our Knowledge of Alloys since 1888. Continuation of Lecture II.

Monday evenings, at Eight o'clock:—

LEWIS FOREMAN DAY, "Some Masters of Ornament." Four Lectures.

LECTURE I.—APRIL 10.—Introduction—The workman and his work—What's in a name?—The revival of art in Italy—Masters of the Trecento, the Quattro-cento, and the Cinque-cento—With illustrations of the work of Orcagna, Ghiberti, Luca della Robbia, Da Settignano, Mantegna, Luca Signorelli, A. Sansovino, School of Michel Angelo, Benedetto da Rovezzano, Marrina, Perugino, Pinturicchio, Raffaelle, Da Udine, Barili, Stephano da Bergamo, Fra Giovanni da Verona, Liberale da Verona, and others.

LECTURE II.—APRIL 17.—The spreading of the Renaissance—Its introduction into France under François I^{er} and the Valois, and its rise in Germany—With illustrations of the works of Primaticcio, Jean Cousin, A. du Cerceau, P. Wœriot, Jean de Pol, F. Siebecq, Orance Finé, Paul van Schelden, Martin Schöngauer, Israhel van Meckenen, Peter Vischer, George Syrlin, A. Dürer, H. S. Beham, Lucas van Leyden, D. Hopfer, Hans Holbein, Hans Mielich, Aldegrever, and others.

LECTURE III.—APRIL 24.—The latter Renaissance—The Netherlands—Louis XIII. and the beginning of the Baroque—With illustrations of the wo of Virgil Solis, Floetner, G. Tory, Le Petit Bernar Hurtu, Fontin, La Quvevellerie, Jost Amman, Wechter, B. Zan, P. Flynt, W. Dietterlin, G. Bar A. Collaert, J. V. de Vries, H. Janssen, S. Vou and others.

LECTURE IV.—MAY 1.—The French styles Louis XIV., Louis XV. and the Rococo—Lo XVI. and the revival of Classicism, and the Emp —With illustrations of the works of Le Pautre, Brun, Jean Vauquer, Jean Berain, D. Marot, A. Boulle, Claude Gillot, Watteau, G. M. Oppenort, de Cuvilliés, J. A. Meissonier, Cauvet, Gouthière, P. Marillier, La Londe, Salembier, Passarini, a others.

MEETINGS FOR THE ENSUING WEEK

MONDAY, MARCH 27...SOCIETY OF ARTS, John-stre Adelphi, W.C., 5 p.m. (Cantor Lectures.) Pr W. Chandler Roberts-Austen, "Alloy (Lecture IV.)

Farmers' Club, Salisbury-square Hotel, Fleet-stre E.C., 4 p.m. Mr. J. K. Fowler, "Pedigree a Age in reference to Breeding."

Royal Scottish Society of Arts, 117, George-stre Edinburgh, 8 p m. 1. Report by Committee Mr. C. A. Stevenson's Paper. 2. Mr. Jo Ritchie, "The Utilisation of Water for Power, a Transmission of same." 3. Dr. Ferguson, " Domestic Hot-water Supply, in which only c Tank is used for Hot and Cold Water."

Geographical, University of London, Burlingtc gardens, W., 8½ p.m. Professor T. G. Bonn "Do Glaciers Excavate?"

British Architects, 9, Conduit-street, W., 8 p Special General Meeting.

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Chemical, Burlington-house, W., 8 p.m. Ann Meeting. President's Address.

TUESDAY, MARCH 28...Sanitary Institute, 74A, Margar street, W., 8 p.m. Professor A. Winter Bly "Sanitary Laws and Regulations Governing Metropolis."

Medical and Chirurgical, 20, Hanover-square, W 8½ p.m.

Civil Engineers, 25, Great George-street, S.W 8 p.m. Mr. G. E. W. Cruttwell, "The F Foundations of the Tower Bridge."

Photographic, 50, Great Russell-street, W.C., 8 p

Zoological, 3, Hanover-square, W., 8½ p.m. 1. M Herbert Druce, "New Species of Lepidopt Heterocera, chiefly from Central and Sou America." 2. Mr. F. E. Beddard, "The Brain the African Elephant." 3. Dr. W. T. Blanfo "The Correct Scientific Name of a Himalay Cuckoo."

WEDNESDAY, MARCH 29...Entomological, 11, Chandos-stre W., 7 p.m. 1. Colonel C. Swinhoe, "Lepidopt of the Khasia-hills. Part I.—Rhopalocer 2. Mr. W. Bartlett Calvert, "New Chilian Le doptera."

CORRECTION.—Page 439, col. 2, line 18, *f* "nearly 12 tons," *read* "1 to 1½ tons."

Journal of the Society of Arts.
No. 2,106. Vol. XLI.

FRIDAY, MARCH 31, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday afternoon, March 27th, Prof. W. Chandler Roberts-Austen, C.B., F.R.S., delivered the fourth and last lecture of his course on "Alloys."

On the motion of the Chairman (Mr. John O'Connor) a vote of thanks to the lecturer for his valuable course of lectures was passed.

The lectures will be printed in the *Journal* during the summer recess.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Monday, March 27th. Present:—Lord Alfred S. Churchill, in the chair; William Anderson, D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Braddon, K.C.M.G., Michael Carteighe, Sir George Hayter Chubb, Francis Cobb, Professor James Dewar, M.A., LL.D., F.R.S., Sir Henry Doulton, James Dredge, Prof. Clement Le Neve Foster, D.Sc., F.R.S., Walter H. Harris, Charles Malcolm Kennedy, C.B., John Biddulph Martin, John Fletcher Moulton, Q.C., F.R.S., John O'Connor, William Henry Preece, F.R.S., Sir Robert Rawlinson, K.C.B., Prof. William Chandler Roberts-Austen, C.B., F.R.S., and Sir Owen Roberts, M.A., D.C.L.

Proceedings of the Society.

INDIAN SECTION.

Thursday, March 9, 1893; Lord Reay, G.C.S.I., G.C.I.E., in the chair.

The Chairman, in introducing Mr. Baines, said he was a distinguished member of the Civil Service of India, and as that service had lately been criticised rather warmly, he thought it was imperative on those who were intimately acquainted with it to do justice to the services it had rendered and was rendering. Germany and France were both bureaucratic countries, though the forms of government were different, but if you asked a representative of the bureaucracy of either of those countries his opinion on the merits of the work of the Indian Civil Service, you would hear nothing but the highest encomiums on the administrative genius displayed by Englishmen, Scotchmen, and Irishmen, in developing the resources of our great Indian Empire. So much for outside expert criticism on the service as a whole. Speaking for himself with regard to its individual members, amongst whom he had many friends, they were men having the highest sense of responsibility and duty, and ready to sacrifice their health and comfort in the discharge of their duties. The greater part of these men performed their arduous duties several months of the year under the most trying climatic influences, and, in most instances, separated from their wives and children; added to this, there was the severe pinch of the financial strain, which affected most of them. He thought no one would grudge them a sincere recognition of their merits. The value put on their work by the natives was shown by the fact that in districts where an English official had not been stationed for some time requests had been made by the inhabitants to send one. One of the reasons why the administrative machinery of India was so efficient was to be found in the admirable services rendered by the large and increasing number of native officials, who have a remarkable aptitude for the details of administrative work, and who are as devoted to their duties as their English colleagues, who are the first to bear witness to their valuable co-operation. Bureaucratic methods have their limitations. The art of government and the art of administration were two distinct arts. Critics of Indian administration were apt to lose sight of that fundamental distinction. The beneficial object of recent legislation had been to widen the representative character of the Councils. Whatever legislation should be enacted, or whatever reforms were introduced, they would be loyally and conscientiously carried out by the Covenanted and Provincial Services, and the people of India would the more readily reap the advantages to be derived from these reforms, because the supreme and provincial governments had at their disposal a body of British and native officials of whose capacity and character any country might justly be proud.

The paper read was—

OCCUPATION AND CASTE IN INDIA, AS SHOWN IN THE LAST CENSUS.

By J. Athelstane Baines.
I.C.S. (Bombay).

About ten months ago I wrote a paper for this Section, on the scope of the Census

in India, and the manner in which the operations were conducted. Amongst other points I laid special stress on the return of Occupation, which, along with that of Caste, or tribe, is the most difficult with which we have had to deal. I may safely state that at least one half of the expense of setting forth the results of the Census is due to these two subjects. They are, therefore, worthy of attention here, if only by reason of their complexity. Then, too, this Society is one treating of arts and industries, and no more suitable topic could be selected from those dealt with in the course of the Census than that of the means of livelihood, in all their ramifications, in a country so widely differing from our own my selection of the subject on which I am to have the honour of addressing you this afternoon. So far I am able to justify satisfy him, I have been induced to add a few words on the subject of Caste. It is a difficult and almost interminable topic, and anyone who undertakes it must do so in the manner in which Nehemiah, I think, describes the Jews as re-building the walls of their city, that is, working at the work with one hand, and carrying their weapon in the other; for there are always plenty of Samaritans hovering round the enterprising investigator, who have in no way forgotten their swashing blow. It will clear the way a bit if I begin by saying that in coupling these two subjects I do not wish it to be thought that I am an adherent of those who hold that Caste is based solely on function, and that the system is developed as the needs of the community are multiplied by increased experience. Nor, again, does it seem to me sound ethnology to attribute to Caste a purely racial basis. The circumstances seem to me to indicate that the truth on this very important question lies, as usual, midway between these two channels of troubled water, and that anyone who has had to navigate amongst the shoals and quicksands of the Census literature on this subject, ought to be able to trim his course accordingly. To the extremes of the system of Caste, as at present organised in India, we may attribute a racial origin; but in the centre, political and sectarian elements, according to local conditions, dispute the supremacy of function; but this last is, on the whole, the determining factor there. To this, however, I must revert later, if time allow, as my first task is to treat of occupation.

I will start in a rather unorthodox manner by throwing in a few words of disparagement of the material I have to work on. If you refer to the *Journal*, you will find that on the last occasion on which I addressed you I ranged myself in the camp of those statists who hold that the machinery of the census is not suited to the collection of information over so complex and varied a field as that of the occupation of a large community. The evidence taken by the Commission appointed by the Treasury in connection with the last Census of this kingdom seems to me to conclusively establish the position I then took. One witness considered that subdividing the column to admit of greater detail would be a help, whilst another showed from the experience of foreign countries, where this plan had been tried, that the results were not improved. Another suggested that the enumerators, if properly trained beforehand, would be able to correct erroneous entries by the householder; but on this point our Indian experience may be brought to bear, for by far the longest and most detailed section of our instructions to the class in question was devoted to the entry of occupation, and, as I showed on the last occasion, each man went through a course of training long before the Census. The results were better, no doubt, than those of ten years ago, but this seems to me to be largely due to the abandonment of the attempt to secure the enumeration of workers at an occupation, as distinguished from those who depend on the worker but take no part in his labour. In the returns on which I am basing my remarks to-day, the figures represent the number of persons that live by each occupation, both workers and dependents. This will account for the large contingent of female priests, and for an addition of the fair sex to our army that might lead the unwary to suppose that Lord Roberts had been reorganising his forces on the principle of the King of Dahomey. I must remind you, again, that the minute subdivision and specialisation of mechanical arts and industries, and the gulf between Capital and Labour, which are characteristic of the organisation of functions in this country, are at present in their infancy in India, so that the material we have collected, though inadequate in respect to the complete statistics that would be essential in an industrial survey of the country, is correct enough, within broad lines, to enable us to appreciate the general distribution of the people according to the means by which they get their living.

We start, then, with a population of 287 millions and over, for all of which, with the exception of about three quarters of a million, some occupation was returned. In dealing with such a mass of figures, the chief difficulty is, of course, that of classification. I will not enter into this question, which bristles with technicalities. The main object in view is to exhibit the nature of the general distribution of functions. To compare it with that prevailing amongst other nations is a task that is beyond the capabilities of any single reviewer, except on the most comprehensive lines. I tried it in more detail ten years ago, and failed to satisfy even myself, so I am glad to find that it has been expunged from the list of international statistics. In the case of India, there are special difficulties arising not, as in England, from the sub-division of industry, but from its combination. Where the same term may denote, in the same village, either a tanner, or a shoemaker, or a watchman, or a horn-blower, and it is uncertain from another whether the person is a fisherman, a water-carrier, a palki-bearer, or a cook, and from a third whether he is grocer, draper, or money-lender, and from a fourth whether he ministers to the object of worship inside a temple or makes leaf platters outside; in such circumstances, I say, classification under a single heading becomes a matter largely of chance. Added to this is the number of synonyms, not arising merely from difference of language, but found in the phraseology of the householder. Sometimes we find twenty or thirty items grouped under a single head. In one province, I remember, the head native compiling supervisor reported to the provincial officer that the names to be tabulated were coming in in "lakhs," that is, by the hundred thousand; but the Hindu, whose pantheon includes 330,000,000 divinities, is apt to think in round numbers, which are more familiar to him than to us. The whole of the heterogeneous mass of names was finally boiled down into about 500 heads, which appear in the Imperial return. These were then grouped under some 80 sub-orders, and re-combined into 24 orders. It is with these last only that I propose to deal to-day.

The Indian community is essentially a rural one, and only 9½ per cent. of the population is found in towns, and less than 5 per cent. live in places of 20,000 inhabitants and over. It does not appear from the census returns that there is any undue development of the town over the country, and the only marked attraction to the former is noticeable in the case of the seaports. Here the movement is of comparatively modern growth, due to the intercourse with foreigners that followed in the wake of the British occupation. In Bombay and Calcutta manufacturing industry has sprung up. In Rangoon and Karachi the foreign trade has been the making of the town. The smaller ports also have shared in the fortune of their neighbours, and Coconada, Maulmain, Calicut, and several others, show a rate of increase far above that of most inland places. Wherever the latter have much increased, it seems to have been in consequence of some change of quite modern date. Cawnpore, for instance, is the centre of the manufacturing enterprise, and the chief wheat mart of a populous territory. Delhi is alive in the same direction, and the great cantonments of British troops have all attracted a considerable number from outside since last census. It may be noticed that, so far as British territory is in question, in nearly every case in which no one of the above-mentioned influences, manufactures, sea-trade, or military concentration, has not operated, the town, that is, if originally a large one, shows a tendency to become stationary, if not to decay. I think a reason for this is not far to seek. The proclivities of the masses are, as I have said, eminently rural, and in different forms, their organisation into village communities, except where it has been broken by the Musulmans, is remarkably complete, and the tendency of such communities is to become self-supporting, so far as the necessaries of a very simple life is concerned. The natural expansion is accordingly in the village first, and then in the market town, which has always been, as pointed out by Sir Henry Maine, a sort of neutral ground for the meeting together of the people of different villages in the neighbourhood. A town larger than this is more of an excrescence in India than it is in England, where it is the work of man, according to one poet, and of Satan, in the view of another. In India it originates with the chief of a more than ordinarily powerful tribe or clan. The nucleus in his Court, with all the appurtenances thereof, such as relatives, which under the patriarchal domestic system are numerous, courtiers, troops, and hangers-on generally. The revenue of the State is remitted or stored in the palace, and all the expenditure that can be spared from military objects is devoted to the personal enjoyment of the

chief and his Court, or the decoration of the town that is growing up around it. It is natural, therefore, that this should become the centre of attraction for all the purveyors of articles of luxury and art; it is, in fact, the only place in which such objects can be safely and remuneratively made, owing to the centralisation of all the power and authority of the chief immediately round his person. Here, accordingly, flourish the jewellers, goldsmiths, weavers of the fine fabrics so famed some generations back, and the makers of arms, who have usually held a higher position in such towns than elsewhere. The result is that described so well by Bernier, for, barring the periodical exodus of the Emperor to the cool valley of Cashmere, his remarks, a bit qualified, apply to most of the capitals of the larger States. He says "a capital city, such as Agra or Delhi, derives its chief support from the presence of the army. These cities rather resemble camps. . . . The king's pay is the only means of sustenance." The emperor was Jahanpanah, the asylum of the universe, to the artist and mechanic as to the noble, the scholar, or the sectarian devotee. So, too, in the Hindu States on a smaller scale. The object of every aspirant to fortune was to attract the notice of the chief, or of one of the current favourites at Court, and to do this was impossible elsewhere but in the capital. All such fictitious encouragement of art and industry is sure to share the fortunes of the source from which it proceeds. We may, for the moment, deplore its absence æsthetically, but most of us are able to look forward to its resuscitation on a wider basis, as the growing wealth of the country widens the area of the cultivation of taste, and the means of indulging it. Is not this indicated by the existence of a Society such as this? Personally, I may say, not being on Tower-hill, or before a jury of Fabians, I am inclined to think that, as there is likely to be always a good deal of human nature left in man, in despite of benevolent schemes for his regeneration, we shall have the rich generally, and the poor always, with us. But this is a digression, and I return to the question of urban development in India. In connection with what I said above about the influence of a local court, I point to Taxila, now underground; to Vijiniagar, deserted and in ruins; to Patna, Benares, and Dacca, which can hardly hold their own; to Lucknow and Agra, which, were it not for their military element, would be in little better plight. Ajodhia is a small centre of ritual and legend. Bijapur, that once sucked in the wealth of the Deccan for miles round, is now but a skeleton, into whose dry bones life is just returning under the magic touch of the iron horse. Lastly, look at Surat, the port of the Moghul Empire, the Gate of Mecca, which, from its foreign relations, was the only place that showed signs of taking rank amongst our modern emporia. Its great river has played it false, and it can no longer be called a seaport at all. When we turn to the native States of India, however, we find the same conditions as of yore, though in a modified form. As far as circumstances permit, the State still centres in the chief, as it did round Caligula or Louis XIV., and, on a very small scale, Rome or Versailles is to be found in every important State. Here, then, the town population maintains its rate of increase.

The winter tourist, that strangest of wild fowl, as he is called by the late "Sir Ali Baba," is wont to make straight for one of these show-places, and on sitting down to the inevitable magazine article, in the full glow of first impressions, he bursts into exuberant praise of the enlightened administration of which he has just seen the end all and be all, and leaves the coral strand with a feeling of contempt for the misguided British administrator, who spreads his funds over his whole estate, instead of putting it all into the shop-window.

Urban life, then, in its most distinctive features, is to be found in these two classes of towns, both of them small ones, the modern port or manufacturing centre, and the capitals of the larger native States. In the rest of the country it is either insignificant or altogether absent. A survey of the constitution of the village community, as it exists in nearly every part of India which has escaped a long period of close contact with Musalman government, will amply show how unfavourable are the conditions to the development of industry, in the modern acceptation of the term. In the first place, the wants to be supplied are few, and the direction in which they tend is scarcely altered by any access of wealth. A wave of prosperity is followed by the substitution of brass pots for earthenware, and a more lavish expenditure on wedding ceremonial, as a rule, or by the increased custom of the village goldsmith, whilst the food and clothing remain nearly the same, and there is little addition to the estate, either in area or labour. Every householder, or nearly so, in the village is an

agriculturist, wholly or partially; nor is he carnivorous, so most of his food is produced within the place itself. The fuel is got from the neighbouring jungle, where the rules of forest conservancy do not interfere, or from the farm-yard, which is conveniently situated, generally speaking, on the ground-floor of the dwelling-house. The strong and durable material that forms the light clothing of the men is usually made in a village close by, and the women—I speak of the middle classes—buy from itinerant pedlars or at the nearest market-town. Brass vessels for household use, the introduction of which is in most parts of India an unfailing sign of increasing wealth, are likewise bought of people not belonging to the village, for it is one of the peculiarities of these communities that after a certain advance in development they close their doors, as Sir H. Maine puts it, to outsiders; and though the grocer, brass-smith, and cloth-seller may settle amongst them if the prospects of trade are favourable, they must be content to live in the village, but not of it. The line is drawn, probably, at the articles that can be produced within the village, and for which resort to the market is not necessary. The grocer, in particular, is an exotic that foretells in the bud, in the present day at all events, the advent of the system of cash advances, and the subsequent full bloom of the money-lender. On the other hand, the goldsmith is an old-established member of the community, for the custom of having ornaments for the person made out of surplus cash, with that of continually having the said articles re-made, as the fashion changes, is one of the oldest of which we have record, and is specially brought to notice by Bernier. Then, too, the barber is a member of considerable standing. His functions are multifarious, and his wife plays a leading rôle on certain not infrequent domestic occasions. Then, again, the carpenter is also the builder and ploughmaker; and wherever carts are in use, he is the wheelwright. A blacksmith, too, is admitted, and a potter who makes bricks and tiles, as well as the earthen vessels for water and cooking. An oilpresser is usually found, and has his defined position. In the march of civilisation of the present generation one of the most remarkable innovations has been the spread of the use of mineral oil for burning in place of that made by pressing the seeds grown in the village. Even into the most inmost recesses of the Himalayas mule-loads of this foreign material are constantly passing, and in some parts of the plains it is noticeable that the Radical who first takes to this is usually hardened enough to proceed to substitute iron cylinders for wooden ones, in his sugar-cane press. The weaver is of lower position, but in many tracts has held his own against machinery for the clothing of the masses, and is a recognised feature in the village. On the contrary, the tailor is not. Most clothes do not want his services, so he is an innovation, like the caps and jackets that he makes, and must keep to the town, and sit in the market-place. There is a very important class who are not allowed to reside within the village walls, though they form a part of every community. In their ranks the watchmen are found, and they are the admitted referees on questions of boundaries, whether of the village, as against encroachments from outside, or in disputes about fields, between members of the community itself. From their immemorial exercise of these functions, as well as from their physical and ceremonial differences from the rest of the villagers, they have been assumed to be the remains of the most ancient inhabitants of the village, retained as helots by the foreigner during the early colonisation of the country from beyond the Himalayas. They are regarded as impure, and amongst other functions it is their duty to remove the carcasses of dead cattle, and their privilege to retain the hide thereof. In this capacity they are credited with frequently taking steps that the supply does not run short, and in cases of disagreement between them and the village notables, I have known the mortality amongst cattle to run up with alarming suddenness and rapidity. On the administrative staff of the village, in the south and west, the headman comes first in rank, the accountant, evidently a later addition to the community, next, but at an enormous interval. Then the watchmen, but all the functionaries in tracts where the village system has been best preserved, are part of the recognised establishment. There are others, too, which are not universally to be found, but are more usual than not, such as the astrologer, the Brahman who performs marriages, the priest of a village temple, and the attendant dancing girls, and so on; these, however, we can afford to pass by as casual contributors to the comfort of the villager. The rest, in the Peninsula at least, where the ruthless heel of the Moghul left little imprint, have each their respective place and function assigned in all village festivals and other public functions. I may quote, in

connection with this point, an extract from a Deccani agreement between two of the family of the headman, executed more than 150 years ago, which runs:—"On the festival of the Holi, it will be customary for both to bake bread. The village musicians shall come to my house first, and play before me till I get opposite your house, when we shall both go together, my bread being carried on the right of yours. On arrival at the tree of worship, I shall tie up your bread underneath it, and we shall then go equally through the worship and the rest of the ceremony conjointly. . . . On the day of the Pola, the bullocks of both shall set out at the same time, yours on the left, and mine on the right, and they shall be walked in this way round Hanuman in procession, but the music shall go before my bullocks on the way home, while yours remain till it returns, and then you shall bring yours home with music also." Now the bullocks of the richest banker in the Deccan will not get a place in that procession for love or money.

Roughly speaking, the classes which I have called above the regular village community constitute about 70 per cent. of the population, and if we include a fair proportion of the priests, washermen, and day-labourers, who are probably more addicted to field-work than to any other, we account for nearly three-fourths of the people of India. But it is not only in the simplicity of its industrial organisation that the village community is peculiar; we have to take into consideration, in connection with our present subject, the way in which that industry is remunerated, or its relation to wages and prices. To begin with, competition is an almost negligeable factor inside the village, except with regard to imported commodities, or those exchanged at the weekly market, where they are subjected to outside influences. The greater number of the village artisans, professionals and menials, are paid either in kind by an annual share or a fixed quantity of the produce of each holding of land, or else by the assignment of a portion of the village lands for the support of each of the above classes, who may thus either cultivate it themselves, or dispose of it otherwise for their own benefit. As each field has its name, such assignments are known by the title of the service rendered, just as we find traces of the custom in some counties of England, and as we read in the Gospels of the "potter's field." In return for this remuneration, the villager—that is, be it understood, the agriculturist—is entitled to receive from the artisan and so on, the performance of all the duties that may be required from a functionary. In some cases cash has to be paid, but the price is more often than not fixed by custom. In former days this was probably the invariable rule, but the increased facilities of communication have tended to introduce, even into the village, the process known in the well-worn phraseology of political economy as the "higgling of the market." The artisan or professional admitted since the village community became stereotyped and closed its doors to fresh membership deals on a purely commercial basis.

In this stage of society, the great preponderance of the agricultural element is no matter of astonishment. In the census returns as they stand, it amounts to 60 per cent. of the entire population; but then this figure refers only to those who returned themselves as agriculturists pure and simple. I have just pointed out above that the village artisan and menial is very largely engaged on the land in some capacity or other, either occupant, tenant, or labourer, and generally the first. It is also the custom for certain other classes to become connected with the land in considerable numbers. Some supplement their ordinary occupation with actual cultivation; others, as in the case of money-lenders and the professional classes, regard land as a good investment for their surplus funds, and if they can acquire an interest in it, let it out to others. The extent to which the non-agricultural classes have been lately connecting themselves with the land, seems to afford unimpeachable evidence of their belief in the equity of the system in force of assessing the State demand on this class of property. Special instructions were given to note at the census all cases in which the principal occupation was combined with agriculture in any form; and, as a rule, the return was fairly good, though probably below the correct figure. It was deficient in Bengal, however, and not prepared for Cashmere and the two great agencies of Rajputana and Central India. Judging of these, however, by the rest, we have to add to the purely agricultural population about five per cent., on account of the semi-agricultural, as above defined. There are, again, the large numbers returned under the head of "general labour," who are really nothing more than field labourers; and the addition of these would bring the proportion of agriculturists to something under 70 per cent., as a whole. The ratio differs, of course, in different parts of the

country; and, taking only that of the people who may be called agriculturists pure and simple, it will be found to range from 77, in Assam, to 56, in the Panjab, in British territory, and from 71, in the Central Province States, in feudatory territory, to 43 in the small States on the Malabar Coast. In the latter, however, the proportion is evidently due to the inclusion of all the field hands in the category of unskilled labour. As a last matter of detail, in connection with these figures, I should state that, out of the 172,000,000 of the purely agricultural population, 150,000,000 are returned as having an interest in the land they till; 2,000,000 grow special produce, such as vegetables, fruit, betel and Areca nut, and so on; nearly 19,000,000 are field labourers or farm hands; and a little under 1,000,000 are set down as estate managers, and their establishments. These last are found chiefly in Bengal and the North-West Provinces, including Oudh, where some of the tenures favour this class of agent.

All other classes of occupation fade into insignificance, numerically, by comparison with cultivation. The next group is that of general labour, which, as I have said, is largely recruited from the agricultural classes; at most, it numbers less than 9 per cent. of the population. Then we have the suppliers of food and drink. These number 5 per cent.; but the class is much intermingled with the commercial groups, because so many grain dealers and grocers, &c., returned themselves simply as "shopkeeper," with no further qualification. In like manner, the fishermen and boatmen cannot be well distinguished, or the milkmen and graziers. Next come the workers in textiles, showing $4\frac{3}{4}$ per cent. The two main divisions of this group are the cotton and the wool-workers. The latter are mixed up with the shepherds, to whose families they belong. The cotton-workers, where not simply women who spin at home, spring from the lower grade of village menials, the *adscripti glebæ* of the tract they once owned. Nearly of the same numerical strength as the weavers come the domestic and personal servants, which include the two great heads of the barbers and the washermen. The former, as I have said, is a personage of village merit. The latter is an excrescence of civilisation. We have a fall between this group and the next of nearly one-half the number of representatives. The professional class consists very largely of priests and the mendicants affiliated to some religious fraternity. That category is to be supplemented, I should say, from the very large supply of mendicants who have not specified whether they claim charity on sectarian grounds or for its own sake. After the service of religion, though at a long interval, come the musical aud dramatic arts. In some parts of India, none of the large temples are without their *corps de ballet*, and in all parts, singing and dancing, and a good deal besides, are combined in the same *artiste*. Medicine is a group that is chiefly taken up with the class that is euphemistically known as "practitioners without diploma." The schoolmaster is the only other profession that seems abroad in India to any considerable extent. Looking at the return, it will be seen that there are very nearly as many persons supported by occupations classed as connected with the administration of the country as there are in the whole body of professions. But it must not be supposed that the 5,500,000 of people in the former group are all bureaucrats let loose to feed on the country at large. More than 3,000,000 represent the village staff mentioned above. Then we find nearly 1,500,000 of the lower grades of functionaries and their families, including constables, watchmen, messengers, and so on. The real bureaucrats—I mean those held up to daily obloquy in the bazaar journalism of Calcutta and Bombay—are the 960 or so of the Civil Service, swamped in the 40,000 coming under the head of "officials of Government and their families." With this group I close the tale of those who bear a proportion of 2 per cent., or nearly so, to the population. I will not go into further detail, beyond mentioning that commerce is said to support 163 in 10,000, and that property, mendicancy (on a non-sectarian basis), and other means of livelihood that do not imply work, support 166. There is much more to be said on the return, especially as to the distribution of certain groups of occupation between the town and the country, and the relative proportions of others in the British provinces and the Native States, respectively. In the Provincial volumes, too, will be found a detail which I have decided to ignore for the Imperial series, namely, the distribution by age and sex. My reason is that given in connection with the change of the system of record, namely, that I wish to show merely the supporting power of each occupation or group. Besides, think of the number of pages that would be required for twenty tables or so, each containing 500 items, shown in four

age-periods by sexes, for town and country separately! The idea recalls Lord Macaulay's reference to the days of Hilpa and Shallum, in connection with Dr. Nares's "Life of Burleigh."

There is, however, one branch of the subject that it may be thought worth while to touch upon briefly. It concerns certain occupations that are not, like those I commented on above, more or less familiar to English ears. Many of those I am addressing are, doubtless, as familiar with the items of this sort which I have set down as I am, and in their case I must make the appeal made by the late Mr. Lowell—"bear with me, for am I not a bore and a brother?" Now the first group of the occupations in question is that of the probably unfamiliar terms. Of these I give a few specimens below:—

Leaf-plate maker.	Player on four-wired instruments.
Eye-cleaner.	Ear-cleaner.
Medicine on the Greek system.	Oil-rubber.
Marriage-arranger.	Guest-inviter.
Women's barber.	Umbrella-carrier.
Sorcerer.	Buffalo barber.
Planet-worshipper.	Storm and hail averter.
Living on hidden wealth.	Giving oracles.
Player on the tom-tom.	Player on European musical instruments.
Player on the round drum.	Player on two-wired instruments.

Then let us take a few described with conscientious minuteness:—

Helping people to put on their clothes.	Taking offerings on the birth of a son.
Making bedstead legs.	Taking offerings as a Saunsi.
Servant for life.	Servant to a candidate.
Beggar giving his blessing.	Buying and eating bread.
Taking fees for preaching and reciting.	

We next have some which seem to be rather doubtful as to their efficacy as means of subsistence:—

Free girl.	Living happily.
Guardian of minor.	Trash seller.
Well-wisher of the public.	Honorary magistrate
Going to Hindustán.	Orphan.
Visitor.	Traveller.
Infant on milk.	Guest.
	Making presents.

Finally, there are a good many whose great merit is their candour, for instance:—

Idler.	Hanger-on.
Gambler.	Tale-bearer from house to house.
Thief.	Village thief.
Dacoit.	Debtor.
Living on loans.	Begging from relations.
Living on son-in-law.	Inheritance from son-in-law.
Giving daughters in marriage for money.	Earnings of daughters.
Rupees 5 a month from stepson.	Dependent on A.P.
Marrier of female servants.	Unemployed because mad.
Witness in court, for wages.	

Several of the above are strange, even to us who have lived in India, by reason of their fantastic appearance in the English garb with which the census enumerator or the householder has induced them. In the vernacular they are at least recognisable, and their meaning is pretty clear, as I have explained in reading them out.

I must now pass on to Caste, prefacing my remarks with the intimation that in the space of the present paper I can do little more than skirt the edges of the subject.

In a survey of Caste, the field to be traversed is so wide, and the detail so minute and varied, that it is out of the question for me to attempt to review the subject more than very sketchily within the compass of this paper. If I confine my remarks to the four corners of the census returns, and take the figures as a photograph of the Caste distribution of the present day, I shall have to enter into somewhat lengthy explanations of the system on which the enormous amount of detail has been classified, otherwise the entries in the general tables would not be well understood. But there is a more serious objection, I think, to treating the subject from merely the standpoint of the present. Caste is the strongest force in India, social and religious. Its operation is not at once discernible, so little can be learned about it in the course of a winter-trip, but its influence is so subtle that even foreigners who have been subject to it for a few years are apt to be to some degree affected by it. It can best be described, accordingly, by treating it historically, and indicating the lines on which it has reached its present development. I must do this very briefly. In an earlier portion of this paper I said that I attributed the development of this institution to conditions partly racial, partly functional, and in places local and sectarian. In origin, I am inclined to think, it is undoubtedly racial.

The immigrants from West Central Asia, whom we are content to call Aryas, appeared in India, not as invaders like their successors from the same quarter, but as colonists, and their acquisition of Upper India and the Gangetic basin was due to slow and gradual occupation. No doubt they were aggressive, and found themselves very superior in civilisation to the races they dispossessed; but all that we read in the epics and other poetry of a later age about pitched battles, wholesale massacres, &c., may be taken as poetic fiction, designed to glorify the existing potentate through the prowess of his forbears. Two races resisted the Aryas. Of the yellow serpent-worshippers of the submontane tracts I do not propose to say anything, as they do not appear to have been far advanced into the plains over which the Aryas spread themselves, and they may have been to some degree akin to the latter in old days of ultramontane habitation. But the advance of the Aryas was throughout opposed strenuously by a black race, all down the Ganges Valley, and it is with these that I am concerned, for there is very little doubt that they were in possession of the whole peninsula, whether autochthonously or not, it matters little. They were displaced from their lands, but not exterminated. The part of them that did not escape to the south-east, either for refuge in the hills, or to fight again on better terms, was enslaved to the soil, and enrolled as helots to the foreign settlements which were formed as the country was pacified. At this stage probably occurs the first cleavage in the social fabric of the Aryas. For here they were first brought into immediate contact with a foreign and inferior race. There is no doubt that interbreeding began very early in the relations between the two races, so that provision had to be made in the community for a third order, resulting from the connection. Then, too, as the occupied area was extended, the frontiers, on which was concentrated the fighting strength of the tribes, receded from the settlements, so that, whilst the functions of the warrior were more strongly differentiated from the rest, throughout the greater part of the Arya pale, the domestic institutions were left to peaceful development. The first result, setting aside the allocation of the half-breeds, was the rise of a priestly class out of the domestic sacrifice, which the fathers of the clan gradually left to members of less political importance at the time. The mediation of one of this order was essential in all relations with the supernatural, and the inclusion within the province of the hierarchy of the peculiar rules regarding marriage, which the Aryas had brought with them from across the mountains had strengthened their hands. These rules were moulded to suit the new circumstances, and no doubt the main object was to preserve the priesthood, and, as far as possible, the military landholding class from the taint of black blood. From the latitude in such matters allowed in the later ceremonial compositions to the Kshatria, and the position assigned to the offspring of a Brahman and a woman of lower race, it is clear that the intention was frustrated by the intimacy that arose between the dark and the fair. The extension of the privileges of casteship to the mixed races that sprang up all round may have been, and probably was, due to the desire of these communities to enter the same fold as their leaders. As, moreover, it is from these that the functional castes take their origin, they rose in importance as civilisation progressed, and established their right of incorporation by conforming to the marriage rule of selecting a wife beyond the circle of agnatic relationship. This they would do by seeking wives amongst those in a neighbouring village who were engaged in the same occupation as themselves, thus cementing the bond in a double way, and leading to the extension of the same rule amongst the rest of their class. Opposition to this development would not be likely from the priesthood, who seem to have manifested marked contempt for Art and mechanical industry, when once they were in power. Later on, too, we can note the extension of the caste system wholesale, when political exigencies dictated the concession, to the chiefs of the powerful tribes of the black race whom it was desirable to conciliate, and the whole of Eastern and Southern India was thus brought under the Brahman hierarchy in the course of time. The results are, that, excepting a few of the Brahmanic divisions of Upper and Western India, the Kshatria dynasties of Rajputana and the Himalayan States, and probably most of the inhabitants of the Cashmere Valley, there is little or no pure Arya blood to be now found in the country. Even the Rajputs are denied the title by Brahmanic tradition, which asserts that the whole of the Kshatria community was exterminated by one of the Brahmanic demi-gods. The Cashmeree, barring the Brahmans, &c., are all Musalmans. Then, too, we must remember that though Caste is, above all things, hereditary and im

mutable, there have been historic occasions on which even Brahmans have been created by royal command, though they are not favourably regarded by the older branches of the caste. As for kings, they seem above the law. For instance, the Raja of Travancore, by origin probably a Nair, and by courtesy a Kshatria, is apt to become a Brahman, for reasons of state; and the process is that of re-birth from a golden cow, the materials of which are then distributed as largess to the Brahmans who perform the rite. The latter act completes the cure of the natural defect. In the present day, the castes that are constantly arising are generally due to sectarian, functional, or social causes. In a few cases the removal of a portion of the caste to a distance beyond touch of the main body causes a split, as the latter is prone to regard with suspicion an offshoot of which it has heard nothing for some years. The sectarian dissensions are apt to revert, after the first fervour has subsided, to the original type, under a fresh title. *Plus ça change, plus c'est la même chose!* Whatever the origin, the constitution of the caste is hieratic, and the main features, due to the social facts touched upon above, are found in all alike. First, there is the recognition of the mediation of the Brahman; then the restriction of marriage to within the caste, but without certain degrees of relationship; thirdly, what is probably an outgrowth of the sacrificial theory of worship, the avoidance of certain articles of food, and the participation of meals with members of the caste only. By this last I mean not the mere taking of casual food or water, but the formal and ceremonial gathering, or sitting down together. So far as communities indigenous to India are in question, observance of the above rules is all that is required of Brahmanic orthodoxy. Violation of the two last rules, and of any of the innumerable bye-laws engrafted on to the system by the caste itself, is a matter for the caste-guild, expiable by fine, penance, and the propitiation by food of a certain number of Brahmans, proportionate to the offence. The deliberate neglect of the first requisite, such as has not infrequently taken place in historic times, necessitates the formation of a new sectarian community, with caste limits of its own. In a generation or two it differs in no way from a caste, except that the stiff-backs of the nonconformists produce priests of their own, whilst the weaker brethren revert to the original fold—on the usual terms.

Throughout the above remarks, I have considered Caste as a purely Brahmanic institution, and this is, I think, the correct limitation of the term. The census returns, however, include in their scope many communities free from Caste, in this acceptation of the word. They purport to show all the social, racial, tribal subdivisions of the population. For example, there will be found in them the Hill Tribes, European, Eurasian, Parsee, Jew and Armenian, on the one hand, and all the Buddhistic races of India and Burma on the other. Again, we have to find room for the large number of Musalmans who do not return any of the indigenous Indian titles, but have affiliated themselves to the foreign element of that faith, as, for instance, Saiad, Shaikh, Pathan, and so on. In North-Western India, there is no doubt a real foreign community of this class, but elsewhere individuals only are met with; and the bulk of those returning it arrogated it to themselves on their conversion, either from casual choice, or because their patron, or the prime agent in their change of faith, was of that race. In other respects, the classification of castes is on a functional base, with as much regard for position in the popular estimation as is possible. The function selected to decide the place of the caste in the list is not invariably that exercised in the present day, so much as that designated by the name of the caste, or by its known history. I must admit that the grouping and arrangement is imperfect, but it is the only way in which it seemed to me practicable to include all the different systems of the country in a single return. I must also make it clear that in spite of the similarity of heading between this return and that of occupations, there is not intended to be any comparison or harmony between the two, for the one refers to the time when the caste was first formed, and the other to the present day. A summary of the distribution of castes and the other social divisions dealt with is appended to this paper, but the figures should be held subject to final revision.

I have said enough of the growth of Caste, I hope, to show, at least superficially, in what its force consists. Marriage and social intercourse is entirely regulated by it. It constitutes the greater portion of the popular Brahmanic religion, the rest consists of worship of the village godlings, and of pilgrimage. While, then, railway communication, which for the time being equalises high and low, operates unfavourably to Caste, it is conducive

) double or treble the attendance at the most opular shrines, so that the account is, on the hole, well balanced. The whole atmosphere f India is, as I have said, laden with it. ikh, Jain, Brahmo, and Lingayat, all secarian revolts, are still within its operation. slam itself is seriously tainted with it. 'he canonization of good men, and the ttribution to them of miraculous powers, the doration of relics of the Prophet, and the airs and gatherings in the name of the faith, re all indigenous to the form of that religion doptedin India. In the Punjab and other parts f Northern India crowds of the agricultural and abouring population worship indifferently at he shrine of Hindu and Musalman saint, and nake use of the ritual of one and the other mpartially, on domestic occasions. When the reat reformer Kabir died, his Hindu folowers were about to remove his body to the urning ghat, so that his ashes might be cattered on the sacred water, in true Brahnanic fashion; but a party of his Musalman dherents arrived on the scene in time, and ntered their protest against the destruction f the work of the Creator by fire, and proluced the shroud for their teacher to be buried n, after the rites of the Prophet. Hostile lemonstrations began, and, to appease the trife, the "corp," as the Scotch call it, ook itself off, and left both parties without the neans of completing their ceremony. Then, gain, in the south and west of India, wherever vhole communities, trading or agricultural, iave been converted, the caste system has been etained, and I know some in which the weekly rayer is duly attended in the masjid, vhilst the Brahman is called in for a vedding. The descendant of the "Old Man f the Mountain," who was settled in Bombay, ised to be, and perhaps still is, regarded as he incarnation of the deity by his followers, vho are converts from Brahmanism, and they iave retained, too, their original rules about uccession and testation. It is only where slam is the living tradition of a ruling race, is in the north of India, or where a foreign ind fanatic element has been implanted imongst an equally fanatic Brahmanic comnunity, that no impression is made on it by the aste system. As for the converts to Christiinity, there has been for some years a tenlency amongst certain classes to set up preensions to caste distinctions, and on the Malabar Coast, where the Roman Catholic ommunity is a very large one, there has been ecognition of Caste since the days of conversion at the hands of St. Francis Xavier. It is said, indeed, that not unfrequently conversion to Christianity or Islam is resorted to by the lowest grade of the Brahmanic community, in order to get thereby a social rise in the world. The fact is, that so far as propitiation by worship is concerned, the native of India is very open to conviction, and he is not initially unwilling to regard the exposition of the tooth of Buddha, or the hair of the prophet's beard, or his slipper, or of the body of the great Christian missionary I have just named, as on an equal footing. Like the Athenians of old, they are altogether too prone to the reverence of the supernatural, and to the recognition of an unknown god. One day I was coming down a hill path, and sat down by a spring to drink and have a smoke. Up the path came a middle-aged rustic, whose clothes betrayed him to be a denizen of the plains. He quickened his pace as the spring caught his eye, in the anticipation of a good drink. But, in the niche of the rock, close by the spring, was a rude image devoutly smeared with red paint, and its two globular eyes picked out with black and white. As soon as this object met the wayfarer's eye, he made a dead point at it, took a long look, failed to satisfy himself as to the identity of the deity, but making the proper obeisance passed on to the water. When he had done his drink, with all the ceremonies appertaining thereto, and was passing on, I asked him, indicating the image, what that might be? He stepped back and had another inspection, then turned round to me, after his final salute to the unknown, and replied that it was probably "some god or other," but he did not know more. He had made it right with him, anyhow, in case he chanced to be one of the malignant deities of the hills, with whom a poor dweller on the flat could not be expected to be acquainted. Now this is the exact attitude of the exoteric Brahmanism of the past towards the system of theology found amongst the black races, and the process of Brahmanising, I mean absorbing the local objects of worship into the orthodox pantheon is going on in this way from year to year, even now. For this reason we cannot get at the census any trustworthy return of the strength of the wild tribes of Central India by means of the religion alone. Half the tribe, generally those on the lower slopes of the hills, will be returned as Hindus, and the rest under the name of their tribal form of faith. We have ignored, accordingly, the distinction of religion in pre-

paring the tables on which I have based my remarks to you to-day.

I will conclude with a few remarks on the physiology of some of the main varieties of human types found in India, in connection with what I have said regarding the racial origin of the earlier castes. I cannot approach this subject with confidence, as we are almost destitute of information about it. The few measurements that have been published by Mr. Risley—about 6,000, in a population of nearly 150,000,000, for Bengal and Upper India—indicate so large an admixture of the lower type with those bearing the caste names of the Arya community, that it is clear that purity of blood became a tradition, honoured in the breach, as the immigrant advanced further into the interior, away from the centres of his race. The measurements, on the other hand, sho so far as their paucity can be said to be co clusive, that the black tribes of the centr and the eastern coast hills of India are unifor in race; so that the whole body can be co nected with the race that predominates Southern India, known as the Dravidia Under the same qualification, they indicate second fact of considerable ethnologic valu namely, that in Eastern Bengal, the pr dominating element is Mongoloid rather th Dravidian in type. Looking at the compar tive insignificance of the data in number, t results give promise of valuable information, the operations be extended on something the same lines to the other parts of Indi This is being done, in the case of certain trib in the Upper Ganges Valley, by Mr. Kitts.

APPENDIX A.—Table showing the Proportional Distribution, by Occupation, of t Population of India.

Order of Occupation or Means of Livelihood.	Actual Numbers.	Proportion per 10,000.			Per-centage of each Order.	
		Provinces.	States.	TOTAL.	Rural.	Urba
I. Administration, &c.	5,600,153	134	61	195	74·39	25·
II. Defence	664,422	12	11	23	29·12	70·
III. Foreign State service	500,030	2	16	18	54·72	45·
IV. Grazing, &c.	3,645,849	86	41	127	93·87	6·1
V. Agriculture	171,735,390	4,718	1,261	5,979	97·28	2·7
VI. Personal and domestic service	11,220,072	296	95	391	77·22	22·7
VII. Food, drink, and stimulants	14,575,593	422	85	507	80·06	19·
VIII. Light, fuel, and forage	3,522,257	101	22	123	83·74	16·2
IX. Buildings	1,437,739	39	11	50	64·53	35·4
X. Vehicles and vessels	146,508	5	—	5	62·28	37·7
XI. Supplementary requirements	1,155,267	34	6	40	63·88	36·1
XII. Textile fabrics and dress	12,611,267	336	103	439	77·34	22·6
XIII. Metals	3,821,433	101	32	133	76·54	23·4
XIV. Earthenware and glass	2,360,623	58	24	82	89·40	10·6
XV. Wood and cane	4,293,012	116	34	150	84·82	15·1
XVI. Drugs, Dyes, &c.	391,575	11	3	14	75·09	24·9
XVII. Leather, bone, &c.	3,285,307	77	37	114	86·03	13·9
XVIII. Commerce	4,685,579	108	55	163	69·58	30·4
XIX. Transport and storage	3,952,993	113	25	138	69·84	30·1
XX. Professions	5,672,191	152	45	197	73·44	26·5
XXI. Sport, &c.	141,180	3	2	5	81·81	18·1
XXII. General labour	25,468,017	641	246	887	89·54	10·4
XXIII. Indefinite and disreputable	1,562,981	24	30	54	84·52	15·4
XXIV. Independent of work	4,773,993	111	55	166	80·31	19·6
Total	287,223,431	7,700	2,300	10,000	90·52	9·4

Note.—The last column shows that, with the exception of agriculture and grazing, every occupation group is represente in the towns in a ratio higher than that of the total urban population. Of the rest, general labour, pottery, leather working and carpentry, all village occupations, come nearest to the general ratio of the rural population.

PPENDIX B.—TABLE SHOWING THE PROPORTIONAL DISTRIBUTION OF THE POPULATION BY CASTE, TRIBE, OR RACE, IN RACIAL OR FUNCTIONAL GROUPS.*

Group.	Per-centage on total population.	Details.
I. Agricultural	34·08	Formerly dominant, 12·49; others, 18·03; labourers, 3·56.
II. Pastoral	4·31	Cattle graziers, 1·85; shepherds, 2·46.
III. Forest tribes	6·20	
IV. Fishers and boatmen	2·51	
V. Artisans	9·66	Weavers, 5·20; carpenters, 1·43: oil-pressers, 1·32; potters, 1·34; goldsmiths, 0·69; blacksmiths, 0·78; others, 0·89.
VI. Personal services and provision of food and drink	4·67	Barbers, 1·13; toddy drawers, &c., 2·19; washermen, 0·93; butchers, 0·33; others, 0·09.
VII. Leather workers and the lower village menials	10·72	Leather workers, 4·08; village menials, 5·40; scavengers 1·24.
VIII. Traders	6·01	
IX. Professions	6·41	Priests, &c., 4·76; devotees, 0·87; writers, 0·26; others, 0·52.
X. Arts	0·39	
XI. Carriers by pack animals	0·53	
XII. Vagrant artisans, hunters, &c.	1·73	Artisans, 0·55; mat-weavers, hunters, &c., 0·87; acrobats, &c., 0·31.
XIII. Indefinite castes	0·91	
XIV. Native Christians and Goanese	1·06	Native Christians, 1·04; Goanese, 0·02.
XV. Musalmans of foreign titles	6·18	Total, Non-Indian, 10·73, of whom probably at least 4 per cent. are of Indian race, though foreign in title.
XVI. Himalayan Mongoloids	0·03	
XVII. Burmese, Assamese, &c.	4·42	
XVIII. Western Asiatics	0·06	
XIX. Eurasians	0·04	
XX. Europeans	0·07	
XXI. Africans	0·01	
Total	100·00	

* This Table is subject to revision, as the final returns for two Provinces have not yet been submitted to the Imperial nsus Office.

In illustration of the main types of countence found in the several races I have men-ned, I have selected a few photographs to converted into lantern slides, which will w be exhibited. I should tell those few of u who are not given to photography, that the des are reproductions from the print, not from e negative, so that the texture of the paper disagreeably apparent. I have to thank Sir eorge Birdwood and Mr. Rose for the loan of e books from which the copies were made. I ll explain as the plates are shown the sub-t, and the reason for its selection.

I have now said all that I think should come thin the scope of this paper, and perhaps ore than some of you may have cared to ar, on the complicated subject of caste velopment in India. In the course of my ırs round India, I did the little I could to make myself familiar with at least the main features of Caste in its local development, which are reputed to be peculiar to the province. I cannot say that I have satisfied myself on the subject; I know no one who does say so of himself, To get a thorough knowledge of it would take years of study, tracing out differences and resemblances to and from their source. Remember, too, that this is only one of the dozen or so distinct topics with which I have to deal in reviewing the results of the Census for the Government. Unfortunately, it is also that on which the more one reads, the more there is found to be read; so that, like Ulysses, in Tennyson's poem, I feel that

> "All experience is an arch, wherethro'
> Gleams that untravelled world, whose margin fades
> For ever and for ever, when I move."

DISCUSSION.

Sir GEORGE BIRDWOOD, K.C.I.E., said:—For me the centre of interest, the palpitating heart of the paper, is in the extracts given from the agreement between the two sons of the headman of a village, as to the official part to be taken by each of them, after their father's death, in the various rural festivals of the Hindu calendar. The Pola,* from *pol*, a "bull," is held on the new moon of either Sravan, the *nakshatra*, constellation, or lunar mansion of the three stars in Aquila, representing the three steps of Vishnu, in which the moon is full this month, corresponding, according to the *sukladi*† reckoning, with August; or on the new moon of Bhadrapad, corresponding, according to the *sukladi* reckoning, with September, and so called from *bhadra-pad*, "beautiful feet," the *nakshatra*, or constellation of Pegasus, the skyey mansion in which the moon is full this month. The Pola is, in short, the harvest festival of Western India, and on this day everywhere along the green hill sides, and over the plains of Maharashtra, the cattle rest from their daily labours, and are led about among the rejoicing villages and homesteads decked in flowers and gay ribbons, and hung with heavy collars of silver bells. The Holi is the Hindu festival of the Vernal Equinox, held on the three to ten days terminating in the full moon of Phalgun, so called after the *nakshatra* or constellation in Leo, in which the moon is full this month, corresponding, according to the *sukladi* reckoning, with our month of March. The last rite in the celebration is the lighting of a great bonfire for baking the sacramental cake *poli*, a word which is the most probable etymon, as the late Mr. W. G. Pedder first pointed out, of the puzzling designation of the Apollo Bunder, Bombay. All the deep dales and wide extended plains of the Deccan, with an occasional high hill, are ablaze with these fires on the night of the full moon in March. The student of sociology will know exactly what the bare extracts given by Mr. Baines, and this bare explanation of the solemnities to which they refer, imply, as indications of the felicity of a people; and the supreme merit of the organisation given by the wise and wary Brahmans to Hindu society is that, excepting where it was destroyed by their ruthless Mohamedan conquerors, it has throughout the length and breadth of India in i- nitely perpetuated the simple idyllic life and bound ss happiness of that stage in the evolution of huma y known as the Age of Faith. And this is e whole reason of my jealousy of any interfer e on our part, not only with the indigenous s of the people of India, but in any departr t of their traditional culture and general civilisa n directly derived from their inner, or, so to , spiritual consciousness. Mr. Baines has well d that caste is the strongest force, social and religi s, in India. It is Hinduism, and without it the Hi s would lose their historical identity, and cease to st as a homogeneous nationality. He is also perf y right in his contention that, in its origin, the te system was entirely racial. Where, I think, he er n this connection, is in underestimating the exte f the Aryanisation of India; and he is certainly te wrong in the conclusion he endeavours to p s, that there is now no pure Aryan blood in e country. The Aryan blood of the Punjab, j- putana, Guzerashtra, and parts of Maharas , particularly the Southern Concan, is as re as it is anywhere; certainly as pure as n ancient Greece and Italy, and in modern Gr e and Italy and Spain, and among the so-ca d "dark Celts" of parts of Ireland and Scotl . Darkness of skin does not arise only from the i r- marriage of white with black races, but from a t of melanismus to which all races living in the tro , particularly where their food is carbonaceous, e subject;* and, anatomically, there can be no ques n of the essential purity of the Aryan type over No - Western and Western India, that is, all thro h the zoological and ethnographical region, inclu g Afghanistan or Western Turkestan, naturalists - signate *India alba*, in contradistinction to *I a nigra*, or Eastern Bengal and Southern India. B I would refer any of my hearers who wish to pu e this particular point in detail, to my Appendix n the "Aryan Flora and Fauna," in Professor x Müller's "Biographies of Words." It must be b e in mind that India lies on the very borders of e focus of prehistoric Aryan evolution; for I have n no argument as yet to shake the conclusion long o arrived at by Rhodes, and so splendidly popular d for the passing generation of Englishmen by Profe r Max Müller, that the centre in which the A n race, as the latest of the three Caucasian races e

* In Teluga, *pola* means "land," and in Sanskrit "a gate," and, emphatically, the "Sun-gate," or "the East."

† The *sukladi* mode begins a lunar month with its *sukla-paksh*, or "bright," waxing fortnight; that is, with the new moon, the full moon falling on the 15th of the month; and is opposed to the *krishnadi* mode of reckoning a lunar month by beginning it on the day following the full moon, with its *kriskna-paksh* or "dark" waning fortnight. The Sanskrit *sukla*, "bright," is the same word as "cyclas" and "ciclatoun" (Persian, *saqlatun*), the mediæval names of a gold brocade, originally of Bagdad [*cf*: "baudekin," "baldacchino"] similar to the Indian kinkob (Persian *kimkha*), the "camoca" of the mediæval trade between the East and West

* Creoles afford an illustration of the early stage at w h this melanismus may set in. They are not half-castes, t the children of pure-blooded European parents residen n the tropics. The term was originally applied to full E - peans born upon the Spanish Main of America, but is w extended to all Europeans of pure descent born anyw e within the tropics; and in the very first generation t r melanosis (using this word in its general and not its spe l medical meaning) is appreciable, as in the notable insta s of Thackeray and De Morgan. It is a common thing to d in the same Anglo-Indian family the children born in I a of a sallow complexion, and those born in England as f h and rosy as their mothers.

ier two being the Hamitic and Semitic), were veloped from an anterior condition of universal *uthismos*, was the region of the Caucasus, extending m the north-west confines of India to the Black a. The argument founded on the fact of the Aryan ces having no common name for the tiger, the n, and the camel—all animals of different parts of is region—is in no way conclusive against its being e cradle of their genesis; for neither have they a mmon name for the reindeer, as they ought to ve if they all originated, as the earlier opponents of eir Asiatic origin held, in Scandinavia. Again, is certain that at least the Avestan and Vedic yans lived together in Bactria before their sepa-tion, and if there was anything in this philological gument, they, at least, should have had a common me for the camel. But they had not, and both the anians and the Hindus to this day, in their classical eech, designate the beast by modifications of its rabic name, first learned by them from the Greeks.* e truth is animals migrate as well as men.† nguistically the Sclaves are closely allied to the tts, the Letts to the Germans, the Germans to the lts, and the Celts to the Latins and the Greeks; d between the Greeks and the Sclaves the missing k is supplied, not only linguistically, but most narkably in respect also of social institutions, by e Aryas of Persia and Hindustan. This link is miss- g out of the circle of Aryan nationalities concen-d in Europe; and the doubt thrown upon the ucasian region as the primitive seat of the undi-led Aryas has almost wholly arisen from the seless assumption that it is more likely that the do-Iranians should have wandered eastward from rope, than that all the European nations should ve wandered westward from Central Asia. But es not the greater energy, the ceaseless restlessness, d the competitive basis of their civilisation from e earliest times of their continuous history, indicate it the latter were really and truly the youthful emigrants from the East westward; while in the comparative inertia of the temperament of the Hindus, their marvellous conservatism, and the surviving co-operative basis of their civilisation, surely we have the almost complete demonstration, apart from philological considerations and popular traditions, that they never moved far from their old autocthonous and, as I assume, Caucasian, home*. Their overwhelming predominance in India is proved by the gradual reduction, by the date of the Christian Era† of the whole of the miscellaneous conglomeration of pre-existing Mongolid, Negroid, and Dravidian races of the Peninsula to the one uniform ethnographical type of the Brahmanical Hindus. The pre-existing Indian races have doubtless reacted on their Aryan conquerors; but the great ethnographical action in India has been that of the conquering Aryas on the conquered Mongolids, Nigritians, and Dravidas, and that not so much by intermarriage, as by the operation of their characteristic social and religious institutions. The assimilative force of the Vedic Aryas in India may be measured with almost scientific accuracy by the fact that, notwithstanding their prolonged political extinction throughout Hindustan by the Mohammedans, yet within 700 years from the invasion of Mahmoud of Ghuznee, they succeeded in almost completing the Arynisation of their Turanian masters. Aryan supremacy in India was overthrown for just a thousand years by the Mohamedans; but during the last and the present centuries it has been completely revindicated by the English; and now that the Aryan tide of armed emigration—for that is what the Russian recoil eastward really means—is once more converging on India, the future of Aryan supremacy in that country and throughout Anterior Asia may, happily, be regarded as at last assured. The Aryas were always emigrating races. Eastward they were checked, and almost abruptly, by the dense Turanian populations of the Ganges Valley, and the yet denser Dravidian populations of Southern India. Westward they were checked only by the sea. But when at last they learned under Columbus and Da Gama to cross the seas, the English colonisation of America and settlement of India began. Still later, the swarming instinct has

* The ordinary Hindustani word for camel [Sanskrit, *kame-a*; Greek, κάμηλος; Arabic, *gamal*, with which compare mulet," from Arabic *hamal*, "to bear,"] is *ont* [compare *tra*, "a buffalo," and "a camel," in "Code of Manu," Iahabharata"]; and this is the name of the animal all over ithern India [Tamil, *ottagam*; Telegu, *wonte*; Malayian, *ta*]. The fossil *Camelus sivalensis*, or Sewalik camel, probably the progenitor of both the Bactrian, or two-mped camel [*C. bactrianus*], and the so-called "Arabian," migratory camel [*C. dromedarius* (δρομαῖος κάμηλος)], l the latter spread from Baluchistan, Persia, and probably estern Turkestan, into Mespotamia, Syria, Arabia, and rica, reaching Egypt, it is believed [notwithstanding the tement in Genesis xii. 16, that it was included, with the d ass, among the presents given to Abraham by Pharaoh] late as the 3rd century A.D. It is nowhere found on the numents of ancient Egypt, and was absent from the intry during the whole time of its subjugation to the mans. Both species are represented on the Assyrian numents, the Bactrian camel being carved with remark-e realism on the "Black Obelisk" of Shalmaneser, B.C. -722.

† See my "Report on Spanish Chestnuts," published by the ia-office, 1892.

* See Mr. T. E. Knight on "Home Rule in Asia," in the *St. James's Gazette*" of 17th March, 1893.

† This date is used approximately, as intermediate between the high antiquity attributed by the earlier European Orientalists to Brahmanism, and the absurdly exaggerated modernity with which it has been discredited by later authorities on the subject; for I am convinced, by my studies in Indian art, that further research will prove the Code of Manu, and the Ramayana and Mahabharata to be far nearer, in their substance and pristine forms, to the dates originally assigned to them than to those to which they have now, for a time, been degraded by certain specialists in Sanskrit palimpsests. Their "low readings" can be but the dates of the most recent recensions of documents that were orally transmitted from father to son, and from teachers to their disciples, for probably centuries before they were reduced to writing.

broken out among the Russians, who, as soon as they find their natural course of extension southward barred, will inevitably turn to the rich plains of Western Turkestan, which, under a civilised system of irrigation, and forest conservancy, are capable of supporting an Ayran population of from 60,000,000 to 100,000,000. And when once again this "seething cauldron" of Jeremiah's vision (i. 3) begins to flow over with, it may be, irresistible momentum, towards the valleys of the Indus and the Ganges, then will come, if not politically forced on beforehand, the greatest crisis in the history of British India; and if I believe that it will be solved altogether in our favour, and without once crossing arms with the Russians, it is not so much in the pride of patriotism as from the most deeply-rooted conviction of my mind, that so long as we rule in harmony with the circumstances that have led to our imperial protectorate over India, that is as the strong and loyal supporters of the idiosyncratic institutions of its ancient people, or in other words, as the revindicators of Aryan ascendancy, our position there, as Lords Paramount of a confederacy of autonomous States, will be found unassailable, or, if assailed, impregnable. In conclusion, Sir George Birdwood observed that the interest with which an overflowing audience had listened, during two hours, to Mr. Baines, was the greatest possible compliment that could be paid to the paper with which he had so considerately favoured them. It was a paper of quite exceptional interest and value. Mr. Baines had earned the best acknowledgments of the meeting, of the Indian Section of the Society of Arts, and of the Society itself.

Mr. W. S. Seton-Karr congratulated Mr. Baines, not only on the matter of his paper, but on the way in which he had delivered it. He himself left India before any of these interesting census inquiries began, but his valued friend, the late Sir George Campbell, who was Lieutenant-Governor of Bengal when the first census was taken, had written some very interesting ethnographical papers dealing with this subject. A few remarks which occurred to him with regard to Caste referred entirely to the Lower Provinces, Bengal and Behar. Although there was no census in his day, one could hardly be a district officer without noticing certain peculiarities. He recollected for instance that in the Sunderbunds, when they were attempting to bring them under cultivation, there was a certain caste of *fakhirs* who earned a livelihood by charming away tigers, and sometimes fevers; and no one would think of putting a spade into the ground until the services of one of these *fakhirs* had been secured. Castes had a tendency to multiply, and one day he hit on a new caste, which no one had even heard of. It was a caste of *rujuks*, or washermen, who had taken to agriculture, and were known as *heli rujuks*, or washermen of the plough. He also recollected talking to several natives, who were *napits*, or barbers, by caste, who told him they had entirely given up their hereditary occupation, and had beco[me] clerks in the Accountant-General's office. The n[ext] case was peculiar. In Lower and Central Beng[al] the larger number of people was Mohammedan, a[nd] there were no less than five separate castes, three of which would intermarry with each other, but [the] other two would not, and would hardly allow Muss[ul]mans to smoke from the same hookah. He a[lso] noted, at the great festival of the Rath Zattra, [in] March, that many more Mohammedans took a ke[en] interest in the procession than Hindus, and th[ey] seemed to enjoy it quite as much as any Hindus co[uld] do. With regard to the question of colour, he rec[ol]lected that the Danga coolies of West Bengal wer[e a] very dark race, probably not Aryans; some of th[em] were taken to Assam, and proved very useful on t[he] tea plantations. Manu, whenever he wrote, descri[bed] Caste by the word *vurna*, or colour, which suppor[ted] the idea that colour was the origin of Caste original[ly]. On one point he differed from Mr. Baines: he thou[ght] that pure Aryans were still to be found, not only [in] Upper India, but in Bengal. By long establis[hed] and credible tradition, the Kulin Brahmans of Ben[gal] derived their origin from five Brahmans, who w[ere] sent down from Kanonj, at the request of t[he] reigning sovereign of Bengal to renovate the religi[ous] feeling in that part of the world. They ca[me] attended by five servants, and he had always und[er]stood that this was the origin of the Kulin Brahm[ans] of Bengal. About the same time, ten ot[her] Brahmans came, and their descendants were kno[wn] as the Varendra Brahmans, who lived on the north or west bank of the Ganges, whilst the others w[ere] at first confined to the right bank, principally [in] Burdwan; but now, of course, they were fo[und] everywhere. He had known many Kulin Brahma[ns], and they were highly efficient public servants as w[ell] as scholars. They would be very much astonis[hed] if they were told that pure Aryan blood did not [run] in their veins. In conclusion, he would say that [the] ramifications of caste all over India were so extens[ive] as almost to defy enumeration. He might say—

> Non mihi si linguæ centum sint, oraque centum,
> Ferrea vox, omnes . . . . comprendere formas,
> Omnia . . . . percurrere nomina possim.

Shrimant Sampatrao K. Gaikwad r[ead] the following translation of a speech made [in] Mahratti by his brother, the Maharaja Gaekwar [of] Baroda, at a prize distribution in his capital:— "Our country's prosperity is greatly hindered [by] the existence of castes and their sub-divisions. M[en] are good and bad according to the virtues [and] capacities they possess. I do not see why [the] benefits of education should not be extended [to] members of the lower castes. In my opinion, i[t is] necessary, for the welfare of our country, that [all] should receive them, and that there should, in [this] matter, be no distinction made between man [and] man, and no caste differences should have influe[nce] on it."

Dr. G. W. Leitner said he would endeavour , answer some of the questions which had been ıt to him. With regard to the title "Zu-l-arnein," ascribed to Alexander the Great, it as simply Arabic, and meant, literally, "endowed ith two horns," or, figuratively, with the posses-on of two continents. The horn was the one ' Jupiter Ammon whom Alexander searched for the Libyan desert. With regard "to the public ıd private causes" which led to his occupying high a position, the public ones were those en-aved on Indian history, even on the sculptures hich, under his influence, were made by Indian ulptors, imitating Greek models, and, as had been ut in a speech (not "Life") of Plutarch, which as too little remembered, "he permeated Asia," specially India, "with Greek institutions." Amongst the private" reasons were the marriages contracted y him and his officers with the natives of the onquered countries, and this explained why so many aimed descent from Alexander. At the same time, it hould be said that the fiction, or fact, of descent from is monarch was really one which had been mostly opagated through Mohammedan writings, especially e Sekandar-nameh. Whenever a person was suffi-ently educated to be a true Moslem, and in a posi-on of rule in Dardistan, he now claimed Alexander his progenitor. With regard to the country of Gilgit ıd the Hunzas, he (Dr. Leitner) was the humble and nocent cause of the spread of that myth. When was there, in 1866, he was in search of remains of lexander, and made inquiries, but, at that time, no ne knew anything about Alexander, and it was since, ırough the extension of Mohammedan influence om India, that the claim to descent from him was vented for Hunza. That dynasty claimed an even gher origin; it was "Ayeshó," or "heaven-born;" s ruler bore a Chinese title and it had nothing to do ith Alexander. "Camel" was, of course, the Arabic Jamal." With regard to the Dôms of Dardistan ing gipsies, he had paid considerable attention to e gipsy language, and he maintained that the Dôms those countries, who were a subordinate clan, were rtainly connected, linguistically, with the gipsies Europe. They were original dwellers on the Indus" or "Sinn"—"Sinkári," our "Zingari." any common words, such as those for water, ver, good, bad, parents, &c., could still be und in so much of the language as survived England. The real Dôm was not like the photo-aph, or, rather, the caricature that had been own, but a person who, like every member of en the humblest Indian caste, had been endowed ith a religion, a folklore, if not a literature of his vn. So far from agreeing with the native gentleman ho had spoken, he rather agreed with Sir George irdwood as to the great importance of Caste, as a eans of preserving all that was noble in Indian ciety. It was better to try to be perfect in e's own Caste than to try to rise into another ss, as so many did in Europe. It was far more noble for a *mehter* or sweeper to consider it a degradation if a Brahman married his daughter, than for a *mehter* to become an imperfect clerk, or even to seek a royal alliance, which both degraded the Rajput, who descended, according to the ordinary notion, and the *mehter*, who ascended. The true ideal was for each man to discharge, as well as he could, the duties of the profession or occupation in which, from the Hindu point of view, he had been placed. This was one of the reasons of the preservation of India—of the bravery of the Rajput, the wisdom of the Brahman, and the wonderful skill of the handicrafts of India, which Sir George Birdwood deserved so much credit for desiring to encourage and to perpetuate. It was to Caste we must look for the preservation of that remarkable loyalty by which India was knit to England. The greatest merit in any paper was that whilst it reflected credit on its author, it also possessed so much suggestiveness as to elicit discussion and difference of opinion, and opened out grave questions for consideration, and that must be truly said of the present one. Some of the entries made in the census report must be received with caution. Some were probably put down to deceive the enumerator, who was not always a philosopher, and was often distrusted as a tax-gatherer; or if the questioned could not read or write, the ridiculous entries of which we have heard so many instances, might be due to the spite of the village headman, who entered him as a thief or a bad man—"bad-másh." There was also a danger in translation; he often found translations made from English into the vernacular which were misleading. "Can you read and write?" seemed a very simple question in the Census paper which he had seen, but it led to misconceptions, and many a man would enter himself as illiterate (though he could read his Mahajani trade character and decipher his wonderful system of arithmetic, which had often beaten some of his own students, who took a degree in mathematics) simply because he did not know Sanscrit or even the humbler Hindi. Again, some who could write, would not admit it for similar reasons. Again, in the frontier provinces, if a lady were asked if she could "read and write," it would be assumed almost as a matter of course to refer to reading Persian, in which there were many naughty stories, and to writing love letters, and she would deny the soft impeachment. It would be like asking an English lady if she read French novels and wrote love-letters. Parents taught their children, husbands their wives, and brothers their sisters. He could imagine nothing more tender, more exalted, or more dignified than the relations of the sexes in India; nothing more chaste, nothing higher in culture, and he looked with astonishment and amazement at some of the efforts made by reformers to teach peoples from whom we, and they, had yet so much to learn. He had been in a Mohammedan Mosque school, where he learned the Koran, and half the pupils were girls; but it never

would have occurred to them to be complimented by being put down as blue-stockings. Pericles said that she was the noblest woman about whom the least was said, either in the way of praise or blame. The Census report was, no doubt, a mine of information, but it could not be thoroughly utilised or relied on, without the necessary explanations given by the associations of the many peoples of India. He could only thank Mr. Baines, and those who had taken part in the discussion, especially Sir George Birdwood, whose views he thoroughly endorsed. How long it would be before they were taken up he did not know, because he saw before him the vanishing vestiges of the most wonderful civilisation and culture dying out, sometimes under the best intentions of the European rulers of India and of the Anglicised natives. He remembered once asking a station-master what caste he belonged to, and he replied that he was a Christian. He asked him how it was that other Christians were not like him? and he replied: "We are Lutheran Caste Christians; our heathen brethren look after our sons and daughters." In other words, they had a public opinion; change of creed made no difference, as long as they preserved what was purely ethnical and professional, and that was Caste. He knew Hindus who used the services of the Church of England, but they kept up caste observances, and were perfect Hindus. One might believe in one God, or three, or a million; but so long as one kept caste observances and ethnic traditions, one belonged to a recognised body, and that is why Caste has so long been a preservative of literature and civilisation. The native Christian who was not a caste Christian, after the first phase of enthusiasm was over, what was he to do? The missionary would not marry his daughter to him; he would not even sit down to dinner with him, and yet he expected that native who might not have five rupees a month, to practise all the Christian virtues. With regard to Bombay, a Khoja, if he were asked what he was, would say a Suni Mohammedan, because it was the most respectable thing for him to say, but in all probability he was not a Suni, but belonged to the sect of the Shiah Ismailians, the miscalled "Assassins" of the Crusades, not that he was not as good a man as any one else who was not called so. But according to the Shiah doctrine it was legitimate to practise concealment or conformity. There was also room for endless discussion about the alleged and improbable migration of the Aryans from the North of Europe to India. When people were dealing with what was conjectural they could assert anything. He had an anthropologist visit him at Simla, who was endeavouring to clear up all ethnological difficulties; but he was surprised at his measurements, and at the results to which they pointed. He came to the conclusion that the Dard Shin race extended to Simla, and that they were a division of the Mongols, and he called them Mongoloid! Anything more extraordinary than the way in which modern reasoning was led captive by scientific terms could not be conceived. As soon as a conjecture was put in scientific language, or in ba Greek, it acquired an importance which plain-spoke information would certainly not give it. The Yunái system of medicine had been alluded to; it was scientific system, just as European surgery wa scientific, whereas our Medicine was still in th empirical stage. If a man, therefore, put himse down in the Census as the only Yunâni doctor i India, he could only say that there were still thou sands of them in India. Of course, he did no expect European doctors to rejoice at this. The tried to weed them out—for few doctors were s generous in their views as Sir George Birdwood He (Dr. Leitner) found the greatest difficulty to kee up a School of Yunâni and Vedic doctors in Lahor to study both their own and our systems of medicine The great thing needed was the combination o whatever might be valuable in modern requirement with whatever was solid and good in ancient India tradition and culture. In that direction lay safety an true progress.

The CHAIRMAN said he had listened to the pape and discussion with very much pleasure, but h should not prolong it, because he thought Caste wa pretty safe for the present. As they had heard, ther was rather a tendency to multiply Caste, and to creat new castes. A wealthy gentleman in Bombay tol him that his caste was so small that he had th greatest difficulty in providing his daughters with suit able husbands. In that instance, Caste led to the ver results which one of the speakers deprecated for that gentleman caused some of the mino members of the caste, who were of very humbl origin, to be educated, in order to fit them to b his daughters' husbands. Caste fellowship obliterate the invidious distinction between rich and poor, an gave the poorer members of the caste a feeling o self-respect, which was very superior to th arrogance too often connected with plutocracy He thought there was a misunderstanding, whic he wished to clear up, as to the meaning o the speech which had been read of his enlightene friend, the Gaekwar of Baroda. What he sai was, not that he was going to destroy Caste but that, in his territory, at least he should appl the principle, which they were bound to apply i British territory also—that those who belonged t the lower castes should have the same opportunitie of obtaining a good education as those who belonge to the higher castes. That was a principle which n Indian administrator could neglect, and also a prin ciple to which he knew that more enlightened Brah mans gave the fullest encouragement. It was one o his pleasantest experiences in Bombay that th Lingayats and other castes formed associations to sub scribe and give scholarships or bursaries to th poorer members of their caste. It was very fortunat that the proclivities of the Hindu race remaine absolutely rural. In India we had not that great ev of Western civilisation which especially affecte

ance, the depopulation of the rural districts; and he ought they might congratulate the Indians on their termination to continue in their villages, and to cul-te the soil as their fathers had done before them. the same time, with the great increase of popula-n, of which the paper gave such startling evidence. was undoubtedly the duty of the English adminis-tion to provide new outlets for labour; and he ought they would all be pleased to hear that by the t mail but one he received a photograph of the st batch of young natives who had received the entiate of mechanical engineering at the Technical stitute in Bombay. He also hoped to receive some y a photograph of those who were being educated the School of Art in Bombay. He was afraid that at institution would not meet with the full approval Sir G. Birdwood, but he hoped the severity of that ntleman's strictures would be mitigated when he told n that in organising it he gave special instructions at the technical training should be mainly carried by those who belonged to the hereditary castes of ndicraftsmen, and that no European methods should vade the province of native artistic skill and in-nuity, and he hoped that principle would be main-ned, to develop all that was worthy of our admir-on in the traditions of Indian art.

Mr. BAINES said that, looking at the time that d been occupied with the discussion, he would ly reply to the vote of thanks, and would deal with y special arguments that bore reference to his per in a note to the discussion as it appeared in e *Journal*. He was much obliged for all the formation Dr. Leitner had given. As to the horns the great Alexander, he was perfectly aware of e attempt made by that youth on the personal operty of Ammon, but, as he did not succeed, it is scarcely a reason for attributing to him the ssession of the horns in question. Alexander also though Dr. Leitner did not mention the fact—took wife Roxana, the "fairest barbarian of Asia," who s a resident of Badakshan, from which country en now the Hunza people get some of their wives. r. Baines also expressed his obligations to Sir orge Birdwood, since, though they stood in oppo-e camps as to the Aryan mixture, it was always ll to have the other side of the question put so ly, and with such appreciation of its importance. e would now express his personal thanks to one ose name had not been mentioned, but whose rks had been of the greatest use to him for some e past, ever since he began to study the many estions involved in the consideration of Caste in India. e meant the "Asiatic Studies" of Sir A. Lyall, ich, in his (Mr. Baines) opinion, contained enough to e an excellent general view, especially to a stranger the subject, of the whole of the field surveyed in course of the present paper, barring the physio-ical elements introduced at the conclusion. He hed to add a few words as to the difficulty of ning an opinion on Caste on the part of one who was studying it in India. He himself had spent most of his service in the Bombay Presidency, and believed that he was fairly well up in the caste questions of the West of India; but he found, when he began to go into the matter, on his tours all over India, that there was a great deal of what he had learned that was entirely provincial, and inapplicable to other parts of the country, and which had to be thrown overboard accordingly. It was most risky for a man, who knew only one portion of India, how-well, to generalise from it. All that he himself had been able to acquire was as nothing that remained. He knew some of the leading points of difference between Bengal and Madras, or between Berar and the Punjab; but he felt that, whatever he had read and seen, there was as much more left for future study.

Mr. BAINES writes:—In fulfilment of what I said in replying to the vote of thanks at my lecture, I add a short reply to what was said by others in the course of the discussion. It is not my intention, even if I had the time, to reply to what does not immediately touch on the points I specially included in my paper for the purpose of having them discussed, any more than to that which, with reference to that paper, I may call posthumous matter, of which there seems to me to be an alarming quantity. First, then, as to Sir George Birdwood's remarks. I join issue with him on the dispersion of the Arya in India—with that from or to Central Asia I decline to deal at present. It certainly seems to me that he has fallen into the not uncommon confusion of treating caste as religion. He says quite truly, that the religion of the Hindu is caste, though I have thought it best to qualify the statement in the paper I read. But are we to understand him to assert that the religion of the present day, or even at the dawn of Christianity, is in any but the most distant degree connected with that introduced by the Aryas from their home beyond the snows? It has been proved over and over again that the Hinduism of the Christian era, so far as the current creed and ritual of the masses are concerned, is almost purely animistic, derived from those of the races displaced by the Aryas, but who have been incorporated more and more into the circle of the orthodox by the genius of the Brahmanic, not the Vedic, system. In this way religion is entirely on the side of physiological ethnology, in proving the absence of Aryan elements in the masses. Then, again, as to colour, the orthodox Brahmanic view is that the Brahman is white, the Kshatria red, the Vaishya yellow, and the Shudra black. The general tone of Indian society is undeniably "subfusc" at present, and the fairest is "wheaten." Sir George Birdwood seems to me to be too positive in his adoption of the theory of tropical melanismus, to account for the change from fair to dark. There are strong facts, as well as arguments, against it, and, in my opinion, the question is still unsolved, and I am one

of the majority in this respect. The question is far too wide for me to undertake to argue it out in this *Journal*, especially as there is nothing new to be said about it. I pass on to another point. When Sir George speaks of the Aryanisation of the Mussulmans of India, he seems to lose sight of the fact that ninety-nine hundredths of those professing this religion are no more than local converts, who have never been forced into more than nominal compliance with the full creed of Islam, so the change involved was, as I have mentioned in the paper, insignificant, from a ceremonial standpoint. As to the proportion of Arya blood now remaining in India, Sir George seems to agree with me as to the territorial extension thereof, but to ask for more, in respect to the class in which it is to be found. I still assert that the masses are nowhere Arya, save in the Punjab. There are pure Aryas amongst the Brahmans of the Konkan coast, and as they have kept their complexions and physical type, this seems to prove that a fatty diet of sugar and ghee does not impart the brow of Æthiop, as has been said it does. Mr. Seton-Karr mentions the Brahmans of Bengal. Well, it is notorious that the five families sent to keep the Brahmanic faith sweet in the marshes of the Delta, have for generations married one wife of their caste, and the other, or rather several others, of lower castes, and the whole crew is now as mixed as the average Britisher. There is a strongly demarcated distinction between the Rarhi and the Varendra type of Brahman, the latter being the higher. I must here put in a word for physiology, which was harshly treated by two of the speakers. This development of anthropology is the product of the last five and twenty years, and with no disrespect to Sir George Birdwood, I may add that we are all grateful to him for having abandoned the study of dry bones so many years back, in favour of the line of artistic specialism in which he reigns supreme. Dr. Leitner, too, has a word or two to throw at this study of skulls and facial angles, and so on. As to his views on it, I think I need not defend the names of European, or world-wide fame, otherwise than by quoting what I presume he will not designate as "bad Latin":—

"Facilis cuivis rigidi censura cachinni."

With that I pass to his remarks on Alexander. As he seems to acknowledge the paternity of the Hunza myth, I need say no more about it. But I fear I must protest against his arrogation to Alexander, with horns or without, of any influence on India, whether in art or anything else. Of the cities founded by the hero, not a trace remains. Indeed, it is clear that they were no more than outposts or forts for overawing the surrounding tribes, and even his successors made no use of them. The few soldiers of fortune he left behind him made the best of their way back to Macedon, when his cardboard empire of the East fell to pieces at his death. Not even Aigos, son of Roxana, visited the plains of India. Two generations later, no doubt, the Punjab was influenced by the introduction of latter-day Greek art, through the Indo-Baktrian rulers, but it never penetrated beyond the north-west corner of India, and I am by no means sure that even there it was not introduced after the Christian era had begun, under the Romans. This is an instance of generalising from provincial knowledge; a dangerous habit, as I have said already. Another instance is the remark about the Doms. Whatever the derivation of the name may be, there is little or no ethnic connection between the scavengers of the lower-middle Gangetic Valley and the low, but not so-low bards and genealogists of the Punjab, or the Dumna of Assam. The study of gipsy dialects is a continual refuge of a linguist out of work, and the derivation of the title of the race given by Dr. Leitner is but one of a hundred, if not more. My own predilection is in favour of Changi, from the Persian instrument of music, called in Turki Chingiani, Europeanised into Zingan, &c. Remember, the gipsies came into Europe as musicians, and have maintained their repute as such ever since. Then, again, as to the remarks on the census taking. No doubt all that Dr. Leitner said is true, so true, in fact, that any Assistant Commissioner of two years' standing knows it, so it is is not likely to have escaped the notice of the very intelligent men who drew up the rules to guide the enumerators. The faults he describes are all found in the Punjab; and, so far as possible, were foreseen and guarded against. The English versions given in the paper were, no doubt, mostly from Madras, where that tongue is much affected in census work by the lower officials. As to the indigenous form or system of education in the Punjab, I see nothing in my paper referring to any such extraneous matter, and, as Dr. Leitner observes, he has written a book on it, which those who wish to learn more of his views on the matter can buy. I think I have now touched on all the points that are of importance in connection with my paper, so I will close these somewhat lengthy remarks. As Horace Walpole, and better men before him, have observed, a busy man has no time to be brief.

Mr. J. B. Hannay writes:—I notice in the printed account of Mr. Perry F. Nursey's paper on the "Manufacture of Non-poisonous White-lead," that he states that the White-lead Company are now "mixing the sulphate with a hydrated oxide of lead . . . so as to render the product equal to the best pigments for use in the trade." Now, hydrated oxide of lead is a much more poisonous substance than the old Dutch white-lead, as it is much more soluble in the juices of the skin, so that Mr. Nursey's paper was misnamed, as he has described an "extra poisonous variety of white-lead."

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

INDIAN SECTION.

On Thursday afternoon, April 6th, Sir Edward Braddon, K.C.M.G., read a paper on "Australasia as a Field for Anglo-Indian Colonisation. Lieut. - General Sir Andrew Clarke, G.C.M.G., presided.

The paper and discussion will be printed in the next number of the *Journal.*

Proceedings of the Society.

FOREIGN AND COLONIAL SECTION.

Tuesday, March 21, 1893; Sir Charles Tupper, Bart., G.C.M.G., C.B., in the chair.

The paper read was—

NEWFOUNDLAND.

By Cecil Fane.

The colony upon the subject of which I have the honour of addressing you this evening claims the proud position of "the oldest British colony," a position that was recognised at the Colonial Conference of 1888, at which its senior representative presided, taking precedence even of the great Dominion of Canada and the wealthy Australian colonies. I wonder if this title of precedence is one of the reasons which induces many Canadian politicians to try and persuade their small neighbour to join the Dominion. Can it be that they hope, by virtue of Newfoundland's position, to preside at any future Conference? Perhaps our chairman can throw some light on this. But, to return to my subject. Newfoundland is an island, with an area of about 40,200 square miles; and there is also included under its government the coast of Labrador, from Blanc Sablon, in the Straits of Belle Isle, to Cape Chidley, in Hudson's Strait, a coast line of some 600 miles in extent, with an area of about 120,000 square miles. The population of the colony was, at the census of 1891, returned at 197,934 souls.

Newfoundland was first discovered by John Cabot in the year 1497, and was formally taken possession of by Sir Humphrey Gilbert on the 5th August, 1583, acting under a commission from Queen Elizabeth. It is recorded that various subjects of other nations were present on this occasion, and that tribute was exacted from them, in acknowledgment of the British sovereignty. I do not propose to go into the history of the colony from those early days (time would not permit of my doing so); but, to those who wish to read about it, I can only recommend Messrs. Hatton and Harvey's excellent "History of Newfoundland." It is sufficient for my purpose to state that it is conclusively proved that, ever since its first discovery, it has belonged absolutely to the British Crown—a marked contrast in this respect to some of its neighbouring colonies in America and the West Indies. The French did, no doubt, at various times, forcibly take possession of parts of the coast; but they never legally exercised sovereignty over any portion of the colony. Unfortunately, as you are all aware, they still exercise these rights of fishery, first granted to them in 1713, over certain portions of the shore; but this is a subject on which I propose to touch briefly a little later on.

The first Governor appointed to the island was Captain Osborn, R.N., in the year 1729. In those days the Governor was invariably a naval officer in command of a ship of war; he had an easy time of it, returning home to England every winter, a practice that I believe continued well into the present century. Now-a-days the duties of a Governor are not so light; he remains there all the year round, and at such times as the recent agitation against the home Government, in respect to French fishery rights, he has much the same position as anyone would have who slipped between the buffers of two railway carriages, being abused by the local Press, because he represented the British Government, and being "heckled" by the British Government, because he could not keep the people quiet. When I was private secretary to the Governor, I had an equally enviable position, for when the papers were tired of pitching into the Governor they had a turn at me. Still, hard words break no bones, and we managed to enjoy life all the same.

The principal towns are St. John's, in the Peninsula of Avalon, with a population of

about 30,000, and Harbour Grace, in Conception Bay, with nearly 8,000. There are several other settlements, which one can hardly dignify by the name of towns, their inhabitants numbering but from 2,000 to 500 each; the principal of these are Carbonear in Corruption Bay, Trinity and Catalina in Trinity Bay, Twillingate and Fogo just south of Notre Dame Bay, St. George's in the Bay of that name on the west coast, Placentia on the west side of Avalon, and many others; while houses and small settlements are scattered all round the coast line, nearly every available harbour having a small community settled in it. St. John's is the capital of the island, being the seat of the Government; it is also the port of call for the mail steamers of the Allan Line, which call once a fortnight on their way from Liverpool to Halifax, and once a fortnight on their return journey to Liverpool; this is, however, but for nine months in the year, and during January, February and March the only communication is by small steamers plying fortnightly between St. John's and Halifax, N.S.

St. John's is principally built of wood, but the business quarter, which stands close to the water's edge, is of stone and brick. Government-house is a large stone building, standing in about eight acres of ground, and the Roman Catholic Cathedral is an imposing stone structure, finely situated on an eminence overlooking the town. The Church of England Cathedral, which was unfortunately destroyed in the great fire of June last, was also a fine stone building, from the designs of Sir Gilbert Scott. The whole town stands on the side of a steep hill, to the north of the harbour, rising abruptly from the business quarter on the water's edge to a height of about 300 feet, the streets running up the hill being almost perpendicular, the upper windows of each tier of houses overlooking the roofs of those below. Three parts of it was swept away in the awful conflagration of last year, and it is a fact worth noting that, when once the fire had gained the mastery, the brick and stone buildings succumbed as quickly as the wooden ones. There are three principal religious denominations in the island—the Church of England, Roman Catholic, and Wesleyan Methodists. Of these, the Roman Catholics are the most numerous, there being two bishoprics of that church—one of St. John's and the other of Harbour Grace. Newfoundland, with the island of Bermuda, is a diocese of the English Church, the Bishop residing at St. John's, with the exception of every second winter, which he passes in Bermuda. The Presbyterians and Congregationalists have also a few followers; while the drums and trumpets of the Salvation Army have even invaded the peace and quietness of the colony.

Education is carried on upon purely denominational lines, each religious persuasion having its own schools, the Presbyterian and Congregationalists combining with the Wesleyans. The Government grants are made on the ratio of so much per head of the population of each denomination, according to the last census. The Education Department is controlled by three Government inspectors, one being of each of the principal religious persuasions. The colony has had a Legislature since the year 1832, but it was not until 1855 that it was granted the privilege of responsible government. The government is at present administered by an Executive Council—reponsible to the Legislature—composed of seven members, in addition to the Governor, who presides. There is an Upper House, or Legislative Council, appointed by the Crown on the recommendation of the Local Government, which may not exceed 15 in number; and, lastly, there is the Lower House, or House of Assembly, of 36 members, elected every four years by 19 constituencies. These members are paid £50 per annum, and are elected by ballot on manhood suffrage. The Legislature sits for about three months every year, commencing at the end of January or beginning of February. The political parties are very similar to those at home—the "Ins" and the "Outs;" they are nominally considered to be the Merchants', or Conservative party, and the People's, or Liberal party; but there is little perceptible difference in their policy, both being apparently prepared to bid almost any price for a return to power. The present Government (a Liberal one) is presided over by Sir William Whiteway, who has a majority in the Lower Chamber of 28 to 8; but it is just as likely that he will be in a similar minority after the next General Election.

It would be interesting to note the rate of development of the colony since the privilege of self-government was first granted, and for this purpose we cannot do better than compare the statistics of trade population and public debt. In 1854 the population was returned at 119,000 souls; in 1864 it had increased to 140,000; in 1874 to 159,000; in 1884 it reached to 193,000, while in 1891 the numbers were just

under 200,000. I have here a comparative statement of the trade during these years, which I will not trouble you with reading, as figures are dull entertainment, but I will merely state that in 1864, nine years after self-government was granted, the exports amounted to £1,111,330 sterling, against £1,549,450 of 1891, showing an increase of £438,120, while the imports at the same periods were £1,067,062 and £1,431,137 respectively, showing an increase of £364,075.

The volume of trade, *i.e.*, the imports and exports added together, was, in 1864, £15 11s. 2d. per head of the population, while in 1891 it only amounted to £14 18s., showing that the trade of the colony has not advanced quite so rapidly as its population has increased.

In 1854, just previous to the colony undertaking the responsibility of self-government, the revenue, exclusive of loans, was £63,587 or 10s. 8d. per head of the population, while in 1891 it had amounted to £338,147 or £1 8s. 3d. per head; which, as the revenue is almost entirely derived from import duties, would show a taxation of about 6¼ per cent. on the imports for 1854, against one of 23½ per cent. on those for 1891. The expenditure for the above years was £64,189 and £381,546 respectively.

In 1854, the public debt amounted but to £113,555, or 19s. 1d. per head, which had increased in 1891 to £1,226,700, or £6 2s. 2d. per head. The above figures show that whatever benefits may accrue to small communities from the privilege of self-government, it does not tend towards the reduction of taxation or indebtedness.

The whole character of the trade is shown by the analysis of the exports, for of the above-mentioned total exports for 1891 the value of £1,386,852, or nearly 90 per cent., was the product of the fisheries, the only other exports of importance being minerals, which attained a value of £118,242, and timber, which was exported to the value of only £5,962.

Those concerned in the question of the Federation of the Empire, either by a Customs Union or other means, will no doubt be interested to hear that, in the year 1891, the exports from Newfoundland to other portions of the empire amounted to £707,320, or 45 per cent. of the whole; while, of the imports, £1,077,530, or 75 per cent., come from within the empire; and, of that amount, goods to the value of £487,855, or 34 per cent. of the whole imports into the colony, are taken from the mother country.

As shown above, the fisheries are still the staple industry; and this is again demonstrated by the census of 1891, in which 53,502 persons are returned as being engaged in that pursuit; only 6,841 being employed in manufactures, 2,715 in commerce, 1,585 in agriculture, and 1,258 in mining; the fisheries thus absorbing 81 per cent. of the workers of the community; in addition to which almost all those returned under the head of commerce are engaged in business connected with the fisheries, while those returned as employed in factories are mainly either engaged in the manufacture of fish products, or in making equipments for carrying on the fishery.

The fishery is of four kinds — the cod, seal, herring, and lobster. Of these the former is by far the greater, the total exports under this head amounting to £1,069,000 in 1891, of which the larger portion is sent to market in the form of "dry cod fish," the methods employed for the cure of which have altered little since the days of the first discovery of the island. As soon as possible after being taken from the water, they are split open and cleaned; they then are heavily salted for some few days, and, lastly, are spread in the sun to dry, sometimes upon the pebbles of a convenient beach, but for the most part upon rough stages covered with fir boughs, which are called "flakes." After about three weeks of this sun-drying, they are stored in the merchants' warehouses ready for export to all parts of the world. I do not know if any of you gentlemen here have ever had the pleasure of tasting this Newfoundland codfish; to my mind the peculiar flavour engendered during the process of sun-drying is far from pleasant; but not to be libellous, I think I had better state that the liking for it comes under that expansive heading, an "acquired taste."

The codfishery is carried on in three separate branches, namely, the Shore, the Labrador, and the Grand Bank fisheries; that of the Shore employing men in small boats and small schooners, who fish with hand-lines and two forms of nets: the fixed net or "trap" and the seine. The Labrador fishery is prosecuted during the summer months by larger schooners sailing from St. John's and other ports, which visit the Labrador Coast and fish both with hand-lines and nets. Many of the St. John's merchants have extensive fish-drying establishments on

that coast, and nearly all the fish caught there is cured before being sent to St. John's, and is in some cases exported direct from the Labrador to the foreign markets.

The Grand Bank fishery is carried on by schooners ranging from 50 to 100 tons. These vessels anchor in the shallow water of the banks right out in the Atlantic Ocean, some 200 miles from the nearest land, where they set their long lines or "trawls" in star fashion, their anchored vessel being the centre. These trawls are overhauled and fresh baited twice a-day by men in small flat-bottomed boats called "dories." As you can well imagine, this is a dangerous service, carried on in all weathers, and it is surprising how few accidents occur. The fish are cleaned and split on board the schooner, and are salted down in the hold ready for sun-drying on their return to port. A trip to the Grand Banks lasts from three to five weeks, when the schooner, whether well fished or not, has to return to port for a fresh supply of bait.

The bait used in all branches of the fishery are of three kinds, the herring, caplin, and squid, which are preserved in ice, and used fresh ; differing in this respect from the French, who always use salt bait, and are thus often able to remain longer on the fishing grounds than their Newfoundland competitors. These bait fishes are found in great abundance on the coasts of the island, the herring in spring, the caplin in midsummer, and the squid at the latter end of the summer ; and it is the possession of this supply of bait that makes Newfoundland such an important factor in all North American fishery questions. It is almost absolutely essential for the successful prosecution of the Grand Bank fishery to have access to the colony's bait supply ; other localities where bait can be obtained are so far from the fishing grounds that much time has to be lost in going to and fro for fresh supplies. Recognising that in this monopoly of the most convenient supply of bait they held the key of the situation, the Newfoundland Government, in 1888, passed the celebrated Bait Act, which empowers the Governor, by proclamation, to prohibit the sale of bait fishes to any but inhabitants of the colony. The main object of enacting this measure was to curtail the French fisheries by stopping their bait supply, the competition of French-caught fish being so severe in consequence of the heavy bounty paid by their Government. It was hoped that, by thus restricting their supply of bait, the French Government might be induced to reduce their bounties, in return for a renewal of the privileges of obtaining bait. Unfortunately, however, this Act, most excellent in theory, has proved most difficult to carry out. The people of the southern shore, who in former days had earned their livelihood by selling bait to the French at the neighbouring French islands of St. Pierre and Miquelon, bitterly resented this interference with their occupation, which meant ruin for them ; as a natural result, they do all they can to frustrate the provisions of the Act, and, aided by the natural configuration of that coast, indented with innumerable bays and creeks, as well as by the atmospheric conditions, which render that locality liable to dense fogs during the spring months, succeed in smuggling large quantities of bait across to the French possessions, in spite of the energetic patrolling of two, or sometimes three, Government steamers.

As long as the Newfoundland Government contented themselves with only enforcing this Act against the unfair competition of their bounty-fed competitors, the French, they had the sympathy, I am sure, of every man under the British flag; but, unfortunately, when the dispute arose with the Canadian Government over the Reciprocity Treaty they wished to make with the United States of America, they retaliated by enforcing the Act against Canadian vessels, refusing to allow their fellow British subjects the privileges which, to make the case worse, they freely accorded to the foreign flag of the United States ; thus alienating from themselves the sympathies they enjoyed before. I am glad, however, to note that, during the last few months, this mistaken policy has been rectified; and there seems a prospect of harmony between these neighbouring colonies, if not a closer alliance still.

Dried codfish is chiefly consumed in countries whose populations are, for the most part, members of the Church of Rome, and where it is impossible to obtain fresh fish. The competition is, however, very severe, the Norwegians putting a large quantity in the market, and there seems little prospect of any expansion in this trade unless some better and more palatable method of cure can be devised. Somewhere about 60,000 tons of this dried fish, equal to 120,000 tons of fresh fish, is exported every year; it does seem a pity that some of this cannot be brought to Great Britain. Amongst the teeming millions of these islands, the demand for fish is increasing day by day ;

our own bounteous fisheries can hardly supply this demand. Cannot the merchants of Newfoundland devise some cure that would suit our English tastes, or is it impossible to carry this fish fresh at a profit over the 1,750 miles that alone separates the colony from the mother country?

Before quitting this most important branch of the trade of the colony, I must make a statement which would seem at first sight highly paradoxical, viz., the fisheries are the main cause of the backward state of the development of the interior resources of the island. How is this? you probably ask. The reply is simple: in ancient days the fishery was conducted entirely by vessels sailing from England. The English merchants did not want the country settled: settlement would interfere with the quietude of their fishing stations; every available space of beach or land outside the dense forests, which in those days reached almost to the water's edge in every harbour, was wanted for fishing establishments and fish flakes. The merchants of England managed to get their views embodied in the various Acts passed for the government of the colony; the Act of King William III., for instance, forbids any person holding private property on any part of the shore "commodious to the fishery." Houses might not be built without a permit from the Governor. Newfoundland was to remain a fishing-station, and a fishing-station it did remain for three centuries. After a time settlers did get a foothold on the island, but merely as settlements of fishermen. The merchants opened establishments in St. John's and resided there, but only as fish merchants. Even in recent years the resident merchants did all they could to discourage the opening up of the country; they wanted every available man to be a fisherman, to catch fish for them, or to build boats and make gear for the fishery. It is only since the population, by natural increase, has grown too large for the purposes of this fishery that any attempts have been made to develop the agriculture and mineral resources; and even in the present day the older school of merchant talks of this development as if it were the ruin of the place. A more enlightened policy has been forced upon those responsible for the government, by the fact of hungry men and women having to be fed. The population had outgrown the fishery, and something had to be done to support the surplus. Now, at last, every effort is being used to open up the country. Railways are being built, and farming operations encouraged; but it is almost too late. For centuries the people of England have been told that the colony is but a barren rock, fit for nothing but a fishing-station. England has been told that the climate is bad—that it is merely a land of bog, rock, snow, fog, and ice. It is hard to undo the libels and misrepresentations of centuries. Those who are at present opening up the country, by clearing lands and making farms, are fishermen. They know nothing about agriculture, yet they find it pays better than a seafaring life, and, once settled in their small homestead, never return to their fishing. If these men, ignorant of agriculture, can do this, what would new blood, accustomed to farming from childhood, do?

The next in importance of the present industries of Newfoundland is the seal fishery. This is carried on by some twenty-two specially constructed steamers, varying in size from 250 to 700 tons register; they sail for the ice-fields on the north-east and west of the island on the 15th of March, and are usually all in port again within six weeks from the date of sailing, each steamer carrying a crew of 150 to 300 men. The seals are of two kinds, the "Harp" and the "Hood;" of which the latter is the larger, and the former are in the greater quantity. They are found in large masses, locally called "patches," on the fields of drift ice. The old seals come up on the ice to give birth to their young ones, which fall an easy prey to the men from the steamers. These young seals are killed when they are about a fortnight or three weeks old, a blow on the head from a gaff being sufficient; they are then immediately "sculped," that is, the fat and skin are removed, while the carcass is left on the ice as worthless. The fat inside the skin varies from $1\frac{1}{2}$ to 2 inches in thickness, and, with the skin, weighs from 40 to 50 lbs. The old seals are also killed, if possible, but being able to take to the water, very few, comparatively, are taken. An old "hood" seal is a formidable animal to attack upon the ice, as its head is protected by the air-bladder, from which it takes its name; and it is almost impervious to a blow from the gaff, unless delivered sideways, which their surprising rapidity of movement renders almost impossible. Neither does the old "hood" always remain on the defensive, but sometimes attacks its pursuer. A friend of mine was trying to kill one single-handed, when it turned on him, and the pursuer became the pursued. The seal was the faster traveller over the rough ice, and my

friend, when it was just on him, fell, luckily, into such a small crevice in the ice, that the seal could not reach him with his formidable teeth. He was rescued by his companion, who killed the seal, as it was making frantic efforts to get at him. This gentleman was telling the story of his narrow escape, and created much amusement, by remarking naïvely to a clergyman, who asked him in solemn tones whether he prayed to God, when he was in such imminent danger of death, "No, I never lost my presence of mind."

The annual catch of seals numbers from 200,000 to 300,000; the fat is manufactured into oil, which, in 1891, was exported to the value of £84,288; while the value of the skins amounted to about £76,000. Both skins and oil are, for the most part, exported to England, the skins being used for the manufacture of the finer kinds of leather. This industry is considered of great importance in the colony, as it employs some 15,000 men, who earn as much as £15 to £20 a head during the five or six weeks they are absent on the voyage, and this at a time of year when they would otherwise be earning little or nothing. "Berths for the ice," as places in the crew of a sealing steamer are called, are almost as much sought after, and as much interest is brought into play, as in the case of Government appointments.

The next important branch of the fishery is the herring trade, the exports under this head being 59,565 barrels pickled, valued at £41,886, and 21,539 barrels of frozen herring, valued at £4,487. The methods employed in the pickled herring trade are much the same as those used in other parts of the world, only slightly more rudimentary. The frozen herring are caught in winter, laid out in flakes in the coldest weather, till they are as stiff as boards, and then packed, either in bulk or barrels, in the holds of schooners, which convey them to the American market, where they are consumed fresh. This trade is mainly carried on by Americans.

The last branch of the fishery is one which has assumed considerable notoriety in the past few years, owing to the disputes with the French. You gentlemen have no doubt heard enough in that time of this lobster factory question, but I, from my official connection with it, have heard more than enough. Nevertheless, I think it may be interesting to explain a little about this industry, and the methods by which it is carried on. The lobsters are usually caught in a modified form of the familiar lobster pot, with which no doubt you are all acquainted. These pots are not, however, set singly, but on long ropes, the pots being about two fathoms apart, and each end of the rope being buoyed and anchored. The price paid to the fishermen for catching the lobsters is from 80 cents to one dollar per hundred, or about one halfpenny a piece, the owner of the factory supplying all the necessary gear.

Now, for a moment, let me describe a "factory." It is usually a rough wooden shed, built on the beach with a small wharf attached, at which the boats land their lobsters. The shed is divided into three parts, the boiling and canning rooms, and the soldering and packing place, besides a little store for supplies and storing the cases of cans. The lobsters on being first caught are boiled in the usual manner, taken to the canning room, the shell broken, and the meat extracted, mostly by girls; the tails are packed in round flat tins, which obtain the highest prices, while the claws and broken meat go into long tins. The lid, in which a small hole is punched, is then soldered on, they are then again boiled to drive out the air, and a drop of solder seals the hole in the lid. An average "factory," *i.e.*, one using 1,000 traps, would employ about five girls and fifteen men, most of the latter being fishermen, and I should say that the outlay in building and plant would be liberally estimated at £300. Of course, there are larger factories and smaller ones also; these are distributed round the whole coast, wherever there is a sufficient supply of lobsters. The export of tinned lobsters amounted in 1891 to 57,291 cases, valued at £89,500.

Before taking leave of this portion of my subject, I think it will be as well to say a few words in reference to the French rights of fishery in Newfoundland. I must preface my remarks by observing that it is a fact beyond all dispute that the sovereignty over the whole colony is purely and solely British, and the French have no right there of any shape or form, with the exception of those of fishery and drying, or preserving the products of that fishery upon certain portions of the shore. The British sovereignty dates back from the formal possession taken by Sir Humphrey Gilbert in 1583, and no part or portion of it has ever been revoked or ceded to any foreign power. The French, from the earliest times, have used the Newfoundland fishing grounds, in common with other nations, paying to the British Government a tribute of 5 per cent. on their catch in return for the

privileges accorded to them. This tribute was, however, unfortunately relinquished by King Charles II. in the year 1675. Previous to this date they had founded the village of Placentia as a head-quarters for their fishing operations, of which they retained possession and fortified during the wars with England. The Treaty of Utrecht, entered into in 1713, provided for the evacuation of this place, but granted them certain rights of fishery. It is by this treaty that they first acquired any legal or valid rights of any kind in the whole island. The rights of fishery then granted were confirmed by the Treaties of Paris in 1763, of Versailles in 1783, and, finally, by the Treaty of Paris in 1814, with only slight modification as to the area and limits of the fishing grounds. I should also mention that the treaty of 1763 cedes the small islands of St. Pierre and Miquelon, on the south coast of Newfoundland, to France for a shelter to her fishing fleet in these waters.

I do not propose wearying you by reading the terms of these various treaties; they have been so freely discussed of late years, that they must be familiar to you all; neither do I propose to enter into an argument as to what are the actual legal rights of France in this question. I merely wish to impress upon you the fact that the manner in which these rights are exercised is pressing very hardly upon, and checking the development of, a British colony. No one can dispute that the sovereignty of the whole island belongs to the British Crown, and no one can dispute that these treaties relate to fisheries, and fisheries alone. But what is actually happening now? One-third of the total coast-line of Newfoundland is a veritable "no man's land;" the French claim the exclusive right of fishing there, and, not contented with this, they also claim that no settlement of any kind shall be permitted within the limits assigned to their fishery, putting forward in support of their claims the declaration of the King of England attached to the Treaty of Versailles —a declaration entered into when the colony was merely a fishing-station, and no settlements, except for fishing purposes, had ever been attempted. I say that it is a disgrace to the civilisation of the 19th century that the mining and agricultural resources of the very finest portion of an English colony should remain undeveloped because forsooth a foreign power has rights of fishery there. In spite of restrictions, people are settling on that coast; but what right or title have they to their homes? None. Every grant of land on that portion of the coast contains a proviso that, in the event of any permanent building being erected, the grant immediately reverts to the Crown. The only methods of communication are by water; there are no inland roads or railways; minerals, in paying quantities, are known to exist; but how can you expect that anyone will invest capital in working them, when they may neither put up the necessary buildings nor provide wharves, or other facilities, for the shipment of their produce, and this merely because a foreign nation says it interferes with their codfishery? What is the extent of this fishery for which these miles of coast-line have to be sacrificed? It is a mere nothing, consisting, when I visited the coast in the summer of 1890, of merely eight establishments, employing about 400 men all told, and these eight establishments occupy but six harbours, three of which are certainly of no use for anything but fishing purposes. To protect this fishery the French Government employ three warships every summer, while England has to employ three more to look after British interests. The commanders of these French vessels act as if the place belonged to them. They seize British property and interfere with British subjects. Our naval officers protest, but protests are of no avail when the harm is done, and our Government lacks either the will or the power to enforce them. Thanks, however, to the energetic action of Sir Baldwin Walker, lately in command of the English squadron, the French have, during the last year or two, been somewhat checked in their high-handed action; but still nothing has been done to relieve the pressure of their claims. As I have said before, this part of the coast is rich in agricultural and mineral wealth as yet undeveloped, and which never can be developed under existing circumstances. There is no analogy for such a condition of affairs in any other portion of the globe. I ask you would it be tolerated for one moment by Canada, Australia, or any of the larger colonies? No, certainly not. But Newfoundland is small and poor, and its voice can only be feebly heard; were she rich and powerful, the French would have gone long ago. There is only one settlement for this question: the French rights must be got rid of, or else exercised in a manner conformably with the usages of civilised nations in this 19th century. It is useless to talk of settling it on the basis of obsolete and unworkable treaties, entered into

at a time when the present situation could not have been foreseen. In these days of rapid increase in the population of Great Britain and her colonies, no available land eminently suitable for settlement can be retained as a barren waste for the sake of a few codfish. I am quite sure that, were the facts of the case thoroughly understood, the existing condition of affairs would not be tolerated for one moment by the people of England.

Now, let us turn for a minute to the mineral resources of the colony, which bid fair to become one of its most important industries in the future; and I must preface my remarks on this head by stating that I am indebted to Mr. Howley, F.G.S., the head of the Geological Survey of the colony, for most of the information I give. Since the earliest times the existence of minerals of economic importance has been known; Sir Humphrey Gilbert was bringing home samples of ore collected by the mineralogist attached to his expedition, when he was lost in the *Delight*; but it was not until 1778 that we hear of any attempt at mining. In that year a copper mine was opened in Shoal Bay, twelve miles south of St. John's, but there is no record of the results of the working.

Desultory attempts were made to work various minerals for many years, and at last, in the year 1864, came the real awakening of this industry. In that year two important events happened, the present Government Geological Survey was established, and the Tilt Cove Copper Mine was opened by Messrs. McKay and Bennett, who may be called the pioneers of mining in Newfoundland. The results of the labours of the former soon established the fact of the mineral wealth of the colony, while the working of the mine showed that this mineral wealth could be worked at a profit. Since then various mines have been opened, some successful and some unsuccessful. And in the year 1891, the value of minerals exported is returned at £118,000, while the census for the same year gives 1,258 men as being employed in this industry.

The minerals at present being worked are copper, iron pyrites, antimony, and asbestos; but samples of almost every known ore have been discovered, amongst which I may mention gold, silver, tin, iron, zinc, lead, plumbago, and coal, while deposits of beautiful marble, gypsum, building stones, grindstones, whetstones, &c., are known to exist. It is also almost certain, from surface indications, that petroleum would be discovered if systematically bored for.

Of these undeveloped minerals, no doubt coal is the most important, two extensive fields of which have been discovered, one near St. George's Bay, in close proximity to huge deposits of iron ore, and the other near Deer Lake, on the Humber River; both of these coal-fields are no great distance from the coast, and should prove of great importance. To show the value of these, I will quote a short extract from Mr. Howley's report on the St. George's Bay fields, dated 6th March, 1890:—"The aggregate thickness of all these seams on the west side of the trough gives between 18 and 20 feet of coal. If we add to this the seams on Robinson's River, and the 'Northern Feeder,' we have a total of about 27 feet altogether, which is about 10 feet less than the North Sydney Section. There are good grounds, however, for believing that other seams not yet discovered exist in this neighbourhood, especially in the central part of the trough." Of the character of the coal he speaks as follows:—"The coal in the Cleary Seam closely resembles in external appearance that of the Sydney Mine, Cape Breton. It is bright, tolerably hard, and breaks into square and oblong blocks. It is a bituminous caking coal, burns well in an open grate, and leaves nearly a white ash. That of the Jukes Seam is entirely different. It presents a brilliant glistening black appearance, breaks into small fragments, and is very brilliant, resembling in this respect some of the Welsh coals. It burns freely in the open air, giving off but little smoke, and leaves a white ash residue. Though bituminous it does not clog the bars of a grate, and altogether seems remarkably free from impurities."

The coal-field of Deer Lake is quite as promising as that described above, but neither of them has been fully explored as yet. This must close my reference, necessarily short, to the minerals of the colony, but I think I have said sufficient to show that they must become one of the main resources of the island in the near future. At present only those deposits found close to the seashore have been worked, and the inland deposits must await the extension of the railway system, while those lying on one-third of the coast-line of the island must remain useless to mankind so long as the French fishery rights are exercised in their present manner.

"Lumbering" is carried on to some extent in the valleys of the Exploits, Gambo, Gander,

and Humber rivers, on the former of which an English company has acquired lumbering rights over 200 square miles of forest, and has erected large saw mills at the mouth of the river, the produce of which is mainly exported to the United Kingdom. On the smaller rivers, and in fact at numerous streams too small to be dignified by the title of rivers, small saw mills cut up timber for local consumption, quantities of birch being manufactured into barrel staves for the fisheries. The geological report describes the timber on the island to consist mainly of "pine, spruce, balsam-fir, tamarac, white birch, and poplar."

A good deal of home-grown timber is also used in shipbuilding, nearly every vessel employed in its vast fisheries being built in the colony. Up to two years ago, the construction of these vessels was very faulty, the planks, of new unseasoned timber, being merely nailed to the frames with common spike nails, no fastenings being employed; but now, owing to the exertion of Captain Cleary, locally styled "the Plimsoll of Newfoundland," an Act has passed the Legislature, under which all vessels proceeding to the deep-sea fishery have to be passed by a surveyor appointed by Lloyd's; while new vessels have to be built under his supervision, under a series of classes specially adapted for local circumstances. Ship-building is also encouraged by a Government bounty, given, according to the different classes, upon the certificate of the surveyor.

What can I say about the agricultural resources of the colony? So little has at present been done in the farming line, and that little, for the most part, in such an unsystematic and ignorant manner, that it is difficult to draw any definite conclusions, or to give statistical information from the results obtained. To begin with, I may say that there are only 64,492 acres of land at present under any form of cultivation, and some of that is of the most primitive kind. The whole produce raised in 1891 amounted, by the Government returns, to but 491 bushels of barley, 12,900 bushels of oats, 36,000 tons of hay, 481,000 barrels of potatoes, 60,000 barrels of turnips, 81,000 barrels of cabbage, and 5,000 barrels of other miscellaneous root crops; while but 1,545 persons are returned as being employed in agriculture, and many of these spent half their time on the fisheries. Nearly all the farming that has been at present attempted is within a mile or two of the seashore, and in the environs of the town of St. John's. There is only one inland farm on the island, that I am aware of, and that is upon the shores of Deer Lake, where a Canadian, of Scotch descent, has established himself, and earns, I am informed, a very comfortable livelihood, bringing his surplus produce down the Humber river in flat-bottomed boats, and exchanging it with the people of Bay of Islands for groceries, &c. With the exception of a few farms in the vicinity of St. John's and one or two other places, nearly the whole area returned as under cultivation is really little more than gardens, being entirely worked by spade husbandry; potatoes and turnips and cabbages being the principal crops, all of which do extremely well. There can, however, be no doubt but that there are many thousand square miles of country, mainly in the valleys of the numerous rivers and streams which intersect the island, that are eminently suitable for all classes of farming. I have seen excellent samples of wheat grown experimentally, though I do not suppose that it could ever compete, even locally, with the cheap flour produced in such quantities on the neighbouring North American Continent. Barley and oats grow well, while potatoes and root crops are as fine—even under the adverse circumstances of primitive forms of cultivation—as those grown in England. The Government Surveyor, in a pamphlet published in 1889, says of the valleys of the Exploit and Gander rivers:—"They contain large areas of fine land. A dense forest, which covers the entire country, has added, and is continually adding, its decomposed woods, leaves, &c., to the surface. When we take into consideration the advantages these tracts possess in points of climate and situation, together with their undoubted superiority of soil, there can hardly be any question as to their future agricultural development." Speaking of the fine lands in the Codroy Valley, he says:—"In some places they are naturally so fertile as to need no manure." He also says:—"I believe the land to be richer than that of Prince Edward Island."

But suitable as parts of the island no doubt are for cultivation, I think more is likely to be done in sheep and cattle raising. In 1891, there were in the colony 60,840 sheep and 23,822 horned cattle; the former, especially, do exceptionally well, as has been conclusively proved, while the latter are not far behind. There are many places which look as if they had been specially designed by nature for ranching; comparatively little winter feeding

is required, and, in the summer months, cattle and sheep grow fat in a few weeks on the luxuriant natural vegetation of the so-called "barrens;" which barrens are merely breezy uplands naturally devoid of timber, or where the primeval forest has been destroyed by fire, while streams and lakes abound. The local meat-market is at present almost entirely supplied from Canada, and this alone would prove of considerable value to anyone starting this industry; the distance from England is but 1,750 miles, which should enable Newfoundland raised cattle to compete on good terms with the Canadian ranches, with their long train and ocean carriage; besides which the shorter winters and less severe weather of Newfoundland ought also to tell in its favour. It is to agriculture and cattle raising that any advance in the prosperity of the island in the future must largely be due. But I daresay you will ask, and it is a natural question, why have these resources, so lavishly bestowed by nature, so long remained hidden and unused? The answer is, as I have mentioned before while speaking of the fisheries, extremely simple. The colony has been sacrificed to its fisheries, the misrepresentation in former days of those interested persons who desired to check settlement for their own selfish ends, is still bearing fruit. There is an old saying of "Give a dog a bad name and hang him." This is as equally applicable to countries as to individuals; and in Newfoundland everything seems to conspire in favour of its detractors. The capital, St. John's, was originally selected in consequence of its convenience to the fishing grounds; it is situated in the most barren portion of the island, right down south on the Peninsula of Avalon, a situation that gives it the full benefit of every fog generated on the banks by the meeting of the Gulf Stream with the Arctic current. It is the only port in the island which is touched at by the mail steamers, and, consequently, passengers passing take their whole idea of the colony from the environs of St. John's. Because its situation renders it liable to constant fog, some people, whose only experience of the island is an hour or two passed in the town while the mail steamer is discharging cargo, will gravely state that they know all about Newfoundland, as they have been there, and that it is merely a barren, rocky place with constant fog. I have even seen the reports of speeches of a gentleman in the House of Commons, on the Newfoundland fishery question, claiming to know all about the people and place, when, to my certain knowledge, that said gentleman has never been longer in the colony than the few hours spent there during the detention of the steamer in which he was travelling to Canada and back. It is such people as these who, by setting up their opinions against those of others who have spent years there, and visited almost every part of the island, do incalculable harm to the colony. Just as well might a passenger on a steamer calling at Gravesend, whose only experience of England had been a foggy day at the mouth of the Thames, declare that this country is nothing but a low-lying marshy land usually enveloped in fog; there would be just as much truth in it as in many of the statements that are made about Newfoundland. The neighbourhood of St. John's is, I admit, subject to sea fogs, especially in the spring months; and in fact an easterly or south-easterly wind usually at all times of the year brings a thick fog rolling in from the Atlantic. Still, on the whole, I have no hesitation in saying that summer weather even there bears favourable comparison to that at home. But in the north and round Notre Dame Bay fogs are almost unknown in the summer time, and the weather to my mind is most delightful. I have sailed from St. John's in a thick fog, and found most delightful weather in the north, and after a three weeks' cruise with hardly a drop of rain even have come back to fog again, which had been continuing on and off all the time during my absence. As a proof of the superior climate of the north, I may say that going from St. John's to the Exploits river, I have found the crops of potatoes and oats fully a month earlier in the latter place than in the former. The west coast of the island, with the exception of the Straits of Belle Isle, is also blessed with an equally good climate, while the agricultural land of St. George's Bay, and other parts of that coast, is as good as any in the colony. With regard to the climate, I may say that the range of shade temperature, from my own observations, has been from 86° to 15° below zero. The former I have often seen reached in the summer, while the latter is a most exceptional occurrence, and only lasting for a few hours; in fact, anything below zero is considered exceptionally cold weather. The winter does not really begin until the middle or end of November, and does not, as a rule, attain its full severity before Christmas, the latter end of January and beginning of February being usually the coldest time,

while by the end of March the last trace of snow has disappeared. The frost, during the winter, is never continuous, being often broken by a week on end of warm weather; in fact, during two winters out of the four I spent in the colony, we hardly used our sleighs a dozen times. The summer is usually started at the beginning of June, and the warm weather continues till the end of September; while October is often one of the most delightful months in the year. When I was going to the colony for the first time, being warned by people who said they knew and by written accounts of the climate in the encyclopedias, I laid in a stock of fur coats, &c., which I found practically useless; an ordinary English ulster being of quite sufficient warmth for driving, except about two or three times in a year. A fur cap, to protect one's ears, and warm fur gloves are really the only wraps required beyond what one would wear in England; so the climate cannot be so severe as some people try to make out.

With regard to the scenery and general configuration of the island, I may say that it is intersected in all directions with beautiful lakes and streams; some people going so far as to use the Irishism that "one-fourth of the land is water," Dense forests clothe the valleys, high hills, almost mountainous, raise their bare heads between, while dry marshes, which look almost like English parks, form charming oases amongst the desert of trees. The whole coast-line is intersected with deep bays and innumerable coves and creeks, into which some river or stream usually empties itself, while the trees in many grow right down to the water's edge, and in some, not even the hut of a single settler breaks the solitude of nature. Notre Dame Bay is crowded with innumerable islands of all shapes and sizes, some bare rocks, others clothed with vegetation to the water's edge, channels so narrow, running between some that a passing vessel almost touches the tree tops with her masts. I have visited almost every part of the coast-line of the island, and know no prettier sight than cruising amongst these islands in summer weather. The sea is as calm as a river, in fact one is virtually sailing in inland water, the outer islands forming a barrier against the Atlantic; in fact, I have seen no lovelier scenery anywhere. It would be a charming locality for a summer cruise in a well-found steam-yacht, more especially as good sport, both fishing and shooting, can be obtained. In a river close there the officers of H.M.S. *Emerald* killed nearly 200 salmon in three days' fishing, while a friend of mine, who was manager of an iron pyrites mine on one of the islands in the bay, killed 120 trout to his own rod, ranging from 5 lbs. to $\frac{3}{4}$ lb. in weight, in a morning and evening's fishing. The neighbouring Hall's Bay, a most lovely arm of the sea, is one of the best places in the island to start for an expedition for cariboo shooting, and I have no hesitation in saying, despite any assertion to the contrary, that a party going into the country from the bottom of this bay, in the beginning of October, should kill, with any luck, the full number allowed by law, *i.e.*, five stag and two doe per gun, and be back at the coast again within a fortnight or three weeks. The other wild game include willow grouse, wild geese (*Anser Canadensis*), snipe, duck, and rabbits; besides foxes, both red and black, otter, beaver, and black bear; and there are still a few wolves left in the interior.

Before bringing this paper to a close, I must say a few words about the people and their life. They are the descendants of Irish and West Country settlers, and in consequence of their extraction from the former, have acquired a peculiar brogue, something between Irish and American; they also seem to have lost the use of the letters "th," calling "the" "de." They are a kindly people, hospitable to a degree, but rather lazy, I am afraid, this latter characteristic having been fostered by circumstances. As the population grew too large for the fisheries, having no other means of livelihood, the unfortunate people had to look to Government to give them food. This also often happens in the event of a failure of the fishery in any particular locality. Unfortunately, the Government, in giving this relief in the past, actuated, no doubt, by a praiseworthy spirit of kindness, have been too lavish in their gifts, the able-bodied men being relieved and fed, with no labour or task exacted from them in return. The long continuance of this system has had the inevitable result of making the people look to the Government for food, and of preventing thrift. I am sorry to have to say that I know instances of men refusing employment; and of being negligent and refusing to fish, even when the fish were actually present in plentiful quantities, saying, as an excuse, that, if they were short in their winter supplies, "the Government would keep them." I am also sorry to say that it is a matter of common talk in the colony that this Government relief has been

used for purposes of influencing votes in an election, the relief being distributed under the supervision of the member for the district. It is sad to see a fine hardy race of men thus demoralised by an iniquitous system, started years ago with the best intentions, but which is against the first principles of political economy, and which seems to be now so deep-rooted as to defy the well-meant efforts of the present Government to eradicate it. The people are, for the most part, very poor, and live from hand to mouth, having no support outside the fishery, which they prosecute in the summer months, the only work done during the winter being the cutting of wood for fire, and repairing their boats and stages. The few who have turned their attention to the cultivation of the soil are in much better circumstances. The foregoing remarks apply, of course, only to the inhabitants of the outlying small settlements and villages; those in the larger towns are better off, being employed by the merchants in the various manufactories, wages averaging from 4s. to 6s. per day.

The railway now in course of construction also gives employment to a large number of men, but this cannot last for ever, and unless the agricultural and mineral resources are speedily developed, those now employed will have to return to the fishery to swell its already overcrowded ranks. There are few wealthy people in the colony, and these are either employed in the Government offices or are lawyers or merchants, and mostly reside at St. John's. The clergy of all denominations, who are really the only better class people who reside amongst the poor in the scattered villages along the coast, are very poor, their stipends hardly permitting them to live better than the fishermen, and they are expected from their modest income to relieve the necessities of their flock. All honour to these men, highly educated and refined, who pass their time doing God's work, isolated, and away from any congenial spirit. And their work is hard; in the winter having often to trudge alone, on snow-shoes, for many weary miles, to visit their people; their parishes extending, in some instances, for thirty miles on each side of their place of residence. I do not think that their hardships and self-denials can be exceeded by any missionaries.

The only railways at present being worked are one from St. John's to Harbour Grace, a distance of 80 miles, with a branch to Placentia of 30 miles extent; but there is at present under construction another railway, starting from a point on the Harbour Grace line, and whose terminus is supposed to be going to be Hall's Bay in the north. This road will be about 250 miles in length, and is to be finished in three years time; at present I believe that 120 miles of it has been completed. It will cross the excellent agricultural land of the Gander, Gambo, and Exploits rivers, and should be a means of developing the country.

I must now conclude, and in doing so, I must thank you for listening to what I fear must have seemed to you a very dull and unentertaining paper. It does not profess to tell you everything about Newfoundland; its shortcomings in that respect are, I fear, numerous, but time will not permit me to refer to everything, and I trust that I have treated those few subjects on which I have been enabled to touch in such an intelligible manner as to remove from your minds many of those prejudices against the colony which are pressing so hard on her and checking her development. This has been my object, and if I have succeeded I shall be more than satisfied, and feel that I have done some small thing, little though it is, to repay the kindness and hospitality that was accorded to me so lavishly by all classes, from the highest to the lowest, of people of Newfoundland, England's oldest colony.

DISCUSSION.

Mr. Nicol Brown said that he had been connected since the year 1881 with mining enterprises in Newfoundland. He had been twice there, and had had some opportunities of studying the geology and circumstances of the country around Notre Dame Bay. The geological features of this district could be briefly described. The uplifting of the country is along the line of mountains extending from Cape St. John in the north-east and extending in a south-westerly direction. The numerous arms of sea, which enter from Notre Dame Bay, have the same general direction as the uplifting of the country; they all run from north-east to south-west. The most important arm in the north side of Notre Dame Bay is called South-West Arm; it extends nearly 20 miles into the country. The prevailing rock is a diorite or serpentine, and it carries the slate bands which, in some instances, when not covered by marshy ground, can be traced for miles. These slate bands have the same general direction as the mountains and the arms of the sea, and they are the carriers of the copper lodes. With such geological conditions, one would think that it was very easy to find a copper lode in Newfoundland. On the contrary, it was very difficult. When the valleys were eroded it was along the lines of the softest rocks;

consequently these slate bands were, as a rule, found in the bottoms of the valleys. These were often covered by swamps, or were filled with mountain lakes or tarns. He had seen many out-crops of the eroded slate bands in different parts of Notre Dame Bay. Some of them were in deep valleys, nearly as low down as the sea level; others were in valleys, which had not been worn so deep, and were high up in the massive diorite of the hills. The bottoms of these valleys were invariably marshy, and there was always a lake or pond near the out-crop of the slates. The elongation of these lakes had the same general direction as the slates, viz., from N.E. to S.W. The marshes and the ponds covered up the out-crops of the lodes, and although they knew well enough they were there, it was very difficult to find them. The indications of copper existed almost everywhere, and the merchants in St. John's had taken out licences for nearly the whole of the ground. This they had done as a speculation, and not with the intention of working them. They hoped that some "boomer" would some day come along and pay a big price for their locations. The Government, under the old Mining Law, used to grant prospecting rights of three miles of ground. This was far too large an area to grant to one applicant. After the licence was granted, the Government were very lax in carrying out the forfeiture clauses, although the claims were left unworked. Doubtless they were under the impression that this would nourish the industry. They, however, overlooked the fact that a mining prospect was of no value whatever unless it was worked by competent men in a profitable manner. A new law came into force about eighteen months ago. It was too early to speak of its operation, but unless the forfeiture clauses were carried out, it would be as inefficient as its predecessor. As all the licences to search for minerals had to be taken out at St. John's, it was expensive for working men living in Notre Dame Bay to travel 200 miles to get a licence. Mr. George Thomson, of New York, suggested that the best way to encourage searching for minerals was to grant licences for small areas, say, not more than one-third of a square mile. These could be issued at the local post-offices throughout the mining districts. In this way poor men living on the spot would get facilities of protection for their discoveries, which would enormously stimulate the prospecting spirit. From the neglect of prospecting, the smelting works at Little Bay were now stopped. About 1,000 tons per annum of refined copper was made there, and they were shut down because a sufficient supply of suitable ore could not be obtained, and yet he believed, from the little prospecting he was able to do in the few brief weeks he was in Newfoundland, that the country round Notre Dame Bay was full of copper-bearing lodes. If the Government wished to do anything to promote the mining industry in this part of the island, they should endeavour to make some good roads into the interior, proceeding inland from the heads of the arms of the bay. It was almost certain that in constructing such roads, many copper-bearing veins would be exposed. The new mines would have the advantage of the new roads to carry the produce to the smelter for realisation. As a rule, the Newfoundland ores were poor, but not too poor to smelt, if not heavily burdened by carriage charges to the smelter. Even the ore, which was too poor to pay for copper, had a value as sulphur ore. The climate of Newfoundland was suitable for making acid, and with acid two other industries could be pursued in Notre Dame Bay, viz., paper pulp making and artificial manure making. The forests afforded immense supplies of timber for the former, and the offal of the seal and other fisheries for the latter. The arms of the sea formed natural harbours of great extent, and steamers of 2,000 tons could come quite close to the land. The cost of building wharves was exceedingly small. It would appear as if Nature had given bountiful conditions for carrying on useful industries in this picturesque bay, which would support thousands of workmen; but without roads, and good mining laws, the outlook was very poor at the present moment.

Mr. Edward Robinson said that having spent some time in Newfoundland, he was able to confirm much of what had been stated by Mr. Fane in his very interesting and instructive paper. One thing must have struck everyone, both from what had been said, and from the photographic illustrations of the homes and occupations of the people, and that was that Newfoundland could not be a very desirable place to live in. The mode of life and the whole picture presented a dismal aspect. Ice and fogs, squabbles about unfortunate French treaties, irritating bait Acts, hostile tariffs, bounty-fed competition, and many other troubles. Under such circumstances industry must suffer very greatly, and both the place and the people were sadly neglected. Such was really the condition of affairs. He was glad to hear from an expert who had just spoken that he thought well of the mining prospects in the north of the island, and he trusted that the hopes entertained by that gentleman would be realised. Speaking of the condition of the people in this connection, they would be glad to know that last year an effort was made by the Mission to Deep Sea Fishermen to improve the condition of the most destitute inhabitants of the colony, especially those on the coast of Labrador. The state of the people there was wretched in the extreme. It was a long and dreary coast, 700 to 800 miles in extent. The inhabitants, amounting to over 6,000, were dependent upon a precarious fishery which lasted only about three months of the year. There was no doctor there, nor education, nor minister of religion, and the people were in a most deplorable state. He was in Newfoundland last year when the Mission arrived, and during its stay in the colony, and he was glad to say that the experiment had been most successful. Among other substantial benefits it had been the means of

bringing to light the condition of that destitute coast, which was not known before. The directors of the Mission had decided to send out their ship *Albert* again with increased facilities for the work, and he hoped the mission would be well supported in its efforts to benefit the people. One great cause of the poverty of Newfoundland was the low prices realised for the products of its fisheries, owing mainly to hostile tariffs, and bounty-fed competition. Some two years since an effort was made to obtain free access to the American markets, and a trading convention was agreed upon. Canada, however, had intervened, and the convention had not been ratified. This was not the time, nor would it be in good taste, in the presence of the High Commissioner of Canada, to discuss the policy of that colony. But it was to be most earnestly hoped that arrangements would soon be made, under which either the two colonies together would reap the benefit of better commercial relations with the States; or otherwise Newfoundland should be allowed to proceed on the lines of the convention already agreed upon by the States. There was an enormous demand in America for the products of Newfoundland, and, if that market could be opened up, it would be an immense benefit. In fact, it would do more than anything else to solve the problems that beset the interests of that little colony. With the development of its mineral resources, and the opening of better markets for its products, he felt sure that brighter days were in store for Newfoundland.

Mr. Douglas Brymner, LL.D., said that he knew the efforts which had been made in early days to settle Newfoundland, but unfortunately without much success. In the early part of the 17th century Sir George Calvert obtained a grant of Avalon, and a commission was sent out by the Admiralty to take charge of the management of the fishery. The inhabitants of Newfoundland were then by no means a peaceable race; there were constant disturbances, so that it was necessary to have a war-ship to keep them quiet. About 150 years ago the Governor of Nova Scotia was also appointed Governor of Newfoundland. In 1745, the French were forbidden to fish along the coast of Nova Scotia under any pretence whatever, and this was about 40 years after the treaty of Utrecht. In 1762, the French took Newfoundland for the purpose of founding a claim to some rights for fishery and other purposes, but they only occupied the place for a few weeks. Newfoundland was not neglected in the early days; in fact, it was attempted to be settled on many occasions, but the cause of the non-settlement appeared to be that the population only remained during the fishing season. In confirmation of the statement made by Mr. Fane, that the population consisted to a considerable extent of West Countrymen, he might say that Richard Whitbourne, the Commissioner of the Admiralty, was a Devonshire man, and published, in 1620, the first emigration pamphlet. Another point in connection with the settlement of Newfoundland in early days, was the fact that the masters of fishing vessels took large crews there but failed to take them back.

Mr. Fane said the law provided that the masters of fishing vessels should take back the same number as they brought.

Mr. Douglas Brymner said no doubt this was so, but the masters found a way of avoiding it. They found it was too great an expense to take the men back that could be traced.

Mr. C. M. Kennedy, C.B., on behalf of the Council, wished to express his thanks to Mr. Fane for the interesting paper, which was a new subject for their proceedings. He had also to thank the gentlemen who had taken part in the discussion. These gentlemen had personal knowledge of the subject on which they had spoken, and the observations which they had been good enough to make would be a valuable supplement to the paper itself. He would not say more at that hour except that they were very glad to have among them Sir Charles Tupper, especially as he had attended at great personal inconvenience. He thought they ought to take this opportunity of expressing their sense of the valuable services of Sir Charles Tupper as High Commissioner of Canada. It would only be when the history of later years was fully written, and became known, that the people of this country would be made aware of the valuable services of Sir Charles in drawing closer together the relations between the mother country and the different parts of the empire.

The Chairman said it now became his very pleasing duty to move a vote of thanks to Mr. Fane for his very able, interesting, and instructive paper, to which they had listened with so much profit and advantage. It was fortunate for them that a gentleman who was called in an official capacity to spend a few years in the oldest colony, Newfoundland, should have devoted his great ability to the very important duty of acquiring all the information he had, and he felt sure the members had greatly profited by his giving them the benefit of that information. There was no doubt that the island of Newfoundland, not only from its antiquity as a British colony, but on many grounds, was one of the most interesting sections of the British Empire. It would be unnecessary for him to occupy their time at any great length after the full manner in which the subject had been treated by Mr. Fane, but he might say that the island of Newfoundland not only possessed perhaps the most valuable and important fisheries in the world, but it had an unrivalled position in regard to the great fishing industry. Enough had been said both by Mr. Fane and the other gentlemen who were well acquainted with the island, to convince every one that it had enormous mineral wealth lying ready for

development. He had no hesitation in saying that the day was not far distant when the great mineral treasures would be developed, and when the island would receive the benefit of the very bountiful manner in which nature had stored these mineral treasures in the bosom of the country. The charming and interesting views and illustrations which had accompanied the paper had shown them the beauty of the scenery. In natural picturesqueness, and in everything that could make the face of the country attractive, Newfoundland had been richly endowed. He had no doubt that at no distant day the prediction of Mr. Fane would be realised with regard to the agricultural development of the country. He had very properly drawn attention to the great advantage which Newfoundland possessed in being so much more accessible to this country than any other portion of the Continent of America. He had no doubt that the agricultural resources, which had been so long neglected, were there to a sufficient extent to render the pursuit of agriculture profitable, and that for cattle raising the place would be found to be admirably adapted. He looked forward with great confidence to the future of that important island. They had all listened with deep interest to the statement made by Mr. Fane with regard to the unfortunate treaties which had so long operated to the great disadvantage of Newfoundland. It was not necessary for him to go over the ground which had been so ably covered, but, he might say, it was within his own knowledge that, not only the governing members of the two great parties in England—not only the leading members of the House of Lords and House of Commons—but the people of England sympathised most deeply with the difficulties under which the people of Newfoundland had been placed by those unfortunate treaties. There was, perhaps, no country in the world that had not always felt bound to regard treaties solemnly entered into, however unfortunately they might press upon the country. He was quite sure, however, that the gentlemen who were charged with the high and responsible duty of administering the public affairs of this great empire had deeply at heart the question of the extent to which Newfoundland was injured by the operation of the treaties, and that every means practicable would be adopted for the purpose of relieving the people of Newfoundland as early as possible from the pressure caused by the treaties. The sympathies of the people of England were deeply moved on the recent occasion of the disastrous fire that overtook the people of St. John's, and the response given to the invitation of the Lord Mayor of London to come to their aid on that occasion was such as to carry conviction to the minds of the people of Newfoundland that they were regarded as brothers, and that they had the heartfelt sympathy of the people of this country, who had, on all similar occasions, always shown themselves ready to do everything in their power to relieve distress. He was glad to know that Canada, on the same occasion, proved that they regarded their neighbours in the sister colony of Newfoundland as entitled to their heartfelt sympathy, and were prepared, and did, without a moment's hesitation, manifest it in the most friendly manner. He could only hope that the people of Canada and of Newfoundland would continue to be drawn every day more closely together. He had no hesitation in saying that they had many interests in common. It was not only to the interests of the people of Newfoundland, but of the Dominion of Canada, and of this great country, that they should co-operate with each other in the closest and heartiest way, to the great advantage of Canada and Newfoundland.

Mr. J. A. Formoy had much pleasure in seconding the vote of thanks which had been so ably proposed by the Chairman. He wished to ask whether the leather industry was prosecuted in Newfoundland. If not, he thought something should be done in this direction. From 200,000 to 300,000 sealskins were annually obtained, and in Newfoundland there were trees which produced tannin in abundance; but, notwithstanding that, the whole of the skins were sent to the mother country to produce leather, which afterwards found its way back to the colony.

The vote of thanks having been carried,

Mr. Fane acknowledged the same. In replying to Mr. Formoy, he said he believed there were only some very small tanning establishments near St. John's; but they did not tan any skins.

Obituary.

Sir George Findlay.—Sir George Findlay, the distinguished General Manager of the London and North-Western Railway, died on the 26th ult., at his residence, Hill-house, Edgware. Of Scotch parentage, he was born in 1829, and educated at Halifax Grammar School. His long connection with railways extended from the year 1845, when, as a youth, he joined Mr. Brassey's staff, then engaged in constructing the Trent Valley Railway from Rugby to Stafford. Early in his career he was manager of the Shrewsbury and Hereford line, which subsequently passed into the hands of the North-Western and Great Western Companies. He afterwards became chief goods manager at Euston, and in 1874 was promoted to the post he continued to hold until his death. He was a member of the Transportation Committee of the Chicago Exhibition, an Associate of the Institution of Civil Engineers, Lieutenant-Colonel of the Railway Volunteers, a prominent Freemason, a Justice of the Peace, an alderman of the Middlesex County Council, and he frequently acted as arbitrator in railway and dock disputes. He was knighted in 1892. He was also a chevalier of

the Legion of Honour. Sir George Findlay was elected a member of the Society of Arts in 1889, and in the following year contributed to the Society a paper "On Modern Improvements of Facilities in Railway Travelling." He was author of a well-known work entitled "Working and Management of an English Railway."

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

APRIL 12.—HARRY W. CHUBB, "The Construction of Locks and Safes."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

APRIL 11.—PROF. PAUL SCHULZE, "History and Development of Pattern Designing in Textiles." THOMAS WARDLE will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

LEWIS FOREMAN DAY, "Some Masters of Ornament." Four Lectures.

LECTURE I. — APRIL 10. — Introduction—The workman and his work—What's in a name?—The revival of art in Italy—Masters of the Trecento, the Quattro-cento, and the Cinque-cento—With illustrations of the work of Orcagna, Ghiberti, Luca della Robbia, Da Settignano, Mantegna, Luca Signorelli, A. Sansovino, School of Michel Angelo, Benedetto da Rovezzano, Marrina, Perugino, Pinturicchio, Raffaelle, Da Udine, Barili, Stephano da Bergamo, Fra Giovanni da Verona, Liberale da Verona, and others.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 10 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis F. Day, "Some Masters of Ornament." (Lecture I.)

Farmers' Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. J. K. Fowler, "Pedigree and Age in reference to Breeding."

Engineers, Westminster Town-hall, S.W., 7½ p.m., Mr. H. Conradi, "The Cleaning of Tramway and other Rails."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. T. Bright, "Underwoods: their Growth and Utilisation."

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Mr. John Ritchie, "Improved Turbines for the Utilisation of Water for Power."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Paper on "Primitive Indian Philosophy."

Cleveland Institute of Engineers, Middlesbro', 7½ p.m.

TUESDAY, APRIL 11...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Prof. Paul Schulze, "The History and Development of Pattern Designing in Textiles."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. J. Macdonell, "Symbolism in Ceremonies, Customs, and Art."

Central Chamber of Agriculture (at the HOUSE OF the SOCIETY OF ARTS), 11 a.m.

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Paper by the late Mr. P. W. Willans, "Steam-engine Trials."

Photographic, 50, Great Russell-street, W.C., 8 p.m.

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Mr. A. Michell Whitley and Dr. Talfourd Jones, "Note on a Cranium from a Grave at Birling, near Eastbourne, Sussex." 2. Dr. Alexander Macalister, "Stray Notes on Egyptian Mummies." 8. Mr. R. Duckworth, "Two Skulls from Nagyr." 4. Mr. P. W. Bassett Smith, "Damma Island and its Natives."

Colonial Inst., Whitehall Rooms, Hôtel Métropole, W.C, 8 p.m. Mr. T. H. Hatton Richards, "British New Guinea."

Asiatic, 22, Albemarle-street, W. 4 p.m.

WEDNESDAY, APRIL 12...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Harry W. Chubb, "The Construction of Locks and Safes."

Geological, Burlington-house, W., 8 p.m.

Japan Society, 20, Hanover-square, W., 8½ p.m. Mr. Daigoro Goh, "The Family Relations in Japan."

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Mr. W. Santo Crimp, "Notes on the Working of the London Main Drainage System."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.

Camera Club (at the HOUSE OF THE SOCIETY OF ARTS), 3 p.m. Annual Conference. Reading of Papers and Discussion.

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

Entomological, 11, Chandos-street W., 7 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m.

THURSDAY, APRIL 13...Camera Club, 3 to 6 p.m., and 8 to 10 p.m. (at the HOUSE OF THE SOCIETY OF ARTS). Renewal of Conference.

Antiquaries, Burlington-house, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, 8 p.m. Mr. W. E. Church, "Tennyson's Poetic Art."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Atmosphere."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. Albion T. Snell, "The Distribution of Power by Alternate Current Motors."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, APRIL 14...Camera Club (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m. Exhibition of Lantern Slides.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Sir William H. Flower, "Seals."

Civil Engineers, 25, Great George-st., S.W., 7½ p.m. (Students' Meeting.) Mr. D. Carnegie, "The Manufacture and Efficiency ef Armour-plates."

Astronomical, Burlington-house, W., 3 p.m.

Junior Engineering Society, Westminster Palace Hotel, 8 p.m. Mr. R. W. Newman, "The Sanitary Engineering of Dwellings."

North-East Coast Institute of Engineers and Shipbuilders, Literary Society's Rooms, Sunderland, 7½ p.m. General Meeting.

SATURDAY, APRIL 15...Royal Institution, Albemarle-street, W., 3 p.m. Mr. James Swinburne (Tyndale Lectures), "Some Applications of Electricity to Chemistry."

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FRIDAY, APRIL 14, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, April 10, Mr. Lewis Foreman Day delivered the first of his course of four lectures on "Some Masters of Ornament."

The lectures will be printed in the *Journal* during the summer recess.

APPLIED ART SECTION.

Professor Paul Schulze, Conservator of the Royal Textile Collection and Lecturer on Art in the Royal Weaving School at Crefeld, read a paper on "The History and Development of Pattern Designing in Textiles" on Tuesday evening, April 11. Mr. Thomas Wardle presided.

The paper and discussion will be printed in the next number of the *Journal*.

Chicago Exhibition, 1893.

OPENING CEREMONIES.

The following Official Programme of Ceremonies for the Opening Day of the Exhibition on May 1 has just been received :—

1. Music, "Columbian March and Hymn" (John K. Paine).
2. Prayer.
3. Presentation of Chiefs of Departments and Foreign Commissioners by the Director-General.
4. Music, "In Praise of God" (Beethoven).
5. Address, and opening of the World's Columbian Exposition, by the President of the United States.
6. Starting of machinery, during which time will be performed "Hallelujah Chorus" (Handel).
7. Official visit from the President of the United States and the Officials of the Columbian Exposition and the World's Columbian Commission to the various Departments, arrangements having been made previously with each chief to receive them.

PASSENGER RATES TO AMERICA.

The Hamburg American Packet Company offer to convey members of the Society of Arts to New York at a rate of £14, single fare, first-class, on the understanding that at least fifty members travel by this line during July and August. The company's steamers sail from Southampton every Friday.

Proceedings of the Society.

INDIAN SECTION.

Thursday, April 6, 1893; Lieut.-Gen. Sir Andrew Clarke, R.E., G.C.M.G., C.B., C.I.E., Acting Agent-General for Victoria, in the chair.

The paper read was—

AUSTRALASIA AS A FIELD FOR ANGLO-INDIAN COLONISATION.

By Sir Edward N. Coventry Braddon,
K.C.M.G., Agent-General for Tasmania.

Between England and her great dependency of India there are constantly flowing two human currents—the one which, coursing eastward, carries with it those who go forth to make or complete their career as members of the Indian garrison; the other, that return stream which brings away with it those who have served their full term of exile, or as full a term as was practicable, and who, with more or less rejoicing, have left the scene of that exile for ever. It is with these retired Anglo-Indians that I propose to deal; the object of this paper being to demonstrate, as fully as time will permit, that Australasia presents a better refuge for their retirement than does our mother country.

Of these Anglo-Indians, the majority, if not well on the spring side of that somewhat elastic period known as the prime of life, have, nevertheless, many years of existence and possible activity before them. No inconsiderable number of them will have brought away a reasonably sound liver, and no contemptible capacity for solid work. For with that pagoda tree, from which, in the good old days, men garnered colossal fortunes, have disappeared many archaic habits of Anglo-Indian life, greatly prejudicial to man's moral and physical conditions. It is no longer the custom, as it was 50 years ago, to drink bumpers out of candle-shades, and beer by the firkin. It is no longer the habit of the Englishman, as

in that olden time it often was, to lead the indolent and sensual life of the rajah in his zenana, lolling through the misspent hours, and rarely undergoing greater physical exertion than that involved in a palanquin ride. And, because of this wholesome change, the Anglo-Indian of the present time is, when he leaves India, physically and mentally capable of entering upon a new career of usefulness, and qualified to enjoy his new life to the full, if but opportunity of enjoyment present itself.

To most of these men some form of useful occupation—more practical than the life of the *flaneur*, or club-lounger—will have become almost a necessity. In India, they will have been workers, and, unless they have spent any portion of their time as "doing duty" officers (those unhappy members of the unemployed military, who have been ironically called "doing duty wallahs," because they had no regular duties to perform), they will have been persistent workers for 25 to 35 years. Many of them will have filled positions of distinction and grave responsibility. Many of them will have directed the affairs and controlled the lives of thousands of their fellow creatures; and all of them (except the "doing duty wallah") will have had brought to them, with each day, its measure of toil and anxious thought—something to live for, something to achieve.

But although, as time has rolled on, the career of the Anglo-Indian has more and more tended to train him as a man of affairs and active proclivities, the opportunities of accumulating fortunes in India have sensibly diminished, if indeed, they have not wholly disappeared. That wonderful pagoda tree has left but few (if any) seedlings or suckers; and, certainly, none that yields the abundant harvest of that regrettable marvel from which Clive, and many another, gathered lakhs as the ordinary orchardist does pippins. India has, for many a lustrum, ceased to be as the cave of Aladdin for even the most fortunate; and, together with this subsidence of the source of wealth, has come about a terrible declension in the value of that stream which trickles now where once it rushed headlong. The rupee that formerly carried its head and tail proudly, as being the equal or superior of the florin, has now to recognise that it may come to be the fellow of the shilling. The Anglo-Indians, whose incomes, such as they are, take the invariable shape of the rupee, have to face a loss of 38 to 40 per cent. upon so much as they expend upon imported goods, or in the form of home remittances, and estimate as great or a greater discount upon such savings as they may remit home. This large discount charge makes saving less easy than it was, and also largely reduces the value of what is saved. To the ordinary mind, it used to be thought no inconsiderable thing to have put by a lakh (100,000 rupees). A lakh was then the equivalent of £10,000; it is to-day equal to £6,041, and, at 4 per cent., would give an annual income of £241 12s. 9d., as against the £400 it would have once yielded.

I have gone into the financial matter at some length because pecuniary considerations largely affect my argument. My point is, that the majority of Anglo-Indians, after the termination of their Indian career, do not make the most of their lives by settling in England, both because of the absence of any sufficient occupation there, and for other reasons. But, of course, if a man has money in abundance, he can purchase occupation, as he can purchase nearly everything, except immunity from gout or dyspepsia, and to such as he my argument does not apply. That man is very well as he is who possesses (1) an English estate that gives him something to do and more to think about as a landlord; (2) a shooting that provides him with healthy exercise in wood and stubble for a fortnight out of the year; (3) a stable that will do him on wheels and in the hunting field; (4) an entrance to the best and noisiest club in England—the House of Commons; (5) the necessary qualification for sundry directorships; (6) a town-house, maintained in a style calculated to push his interests, Parliamentary and otherwise; (7) a box at the opera; (8) membership of half a dozen first-class clubs other than the House of Commons; (9) a substantial deposit at the Army and Navy Stores, out of which his wife may find occupation; (10) several other things that do not occur to me at this moment; and (11) ample means to live hundreds of miles away from most of these possessions—at Monte Carlo, or Nice, or in the Riviera, or on the Nile, or elsewhere, or everywhere else—during nine months out of every twelve.

But they are a very small minority among Anglo-Indians who can afford even a large proportion of these good things. Those who make up the overwhelming majority are men who retire upon incomes that can only be enumerated by hundreds; who bring away from the sunny East the tastes of millionaires with the means of a bank clerk, and who live

on in England a life as largely devoid of interest as it is replete with self-denial. He who for 25 or 30 years has kept a stud of horses, now hesitates to employ the occasional Hansom, nay, even descends to the democratic 'bus. He who has for a couple of decades feasted his fellows as Lucullus did, now pauses ere he asks a friend to lunch. A sorrow's crown of sorrow is upon them in the memory of happier times—a vain regret that they who once were genuine workers now have no work to do. For, how many of the hundreds that come home to settle find occupation, with or without emolument? For a select few there are the Indian Council, the Privy Council, and similar official spoils that confer pay as well as honour upon the fortunate holders. Some few, as directors of financial institutions or joint-stock companies, enjoy their board meetings and their fees as long as the ventures that they direct continue to exist, and the shareholders retain them in the direction. Three or four are members of the present Imperial Parliament—the only Parliament, by the way, that knows not payment of members—and here and there one has won a seat upon an education board, or in some other body existing for purposes of local government; or has, by dint of enormous influence, the charge of a jail, or a position in the constabulary. Here and there, again, one finds wholesome occupation in literature, and lives happily and contentedly with his books and MSS.

But, as I have said, these are the few, and if we add to their number those who do occasional work as agents for a wine or tea firm—those who become glorified vintners and grocers for the sake of employment, or the small commissions that employment brings to eke out a scanty income—even then, the total will remain but small as compared with the total of those who have no occupation of a business character whatever.

As to this unemployed majority, we may divide them into two classes:—(1) The men who can effectively kill their time by means of such pleasures as are within their reach; and (2) the men who cannot do this. My friend A, who, living in the depths of Loamshire, spends one-third of the year in buying a hunter, and two-thirds in riding it, and who asks for no other occupation than that afforded him by stable, paddock, and the hunting-field, and such literary support as the *Standard* and *Sportsman* furnish; he is happy and contented in his own philosophic way. So is my friend B satisfied with a diurnal programme that is comprised of three items, viz., 4 hours for meals, 8 hours for whist, and 12 hours for sleep, varied only by the lengthening of the whist period, and the contraction of that devoted to slumber. It would be difficult to convince A and B that they would be happier and lead more useful lives in Australasia. They do not desire other or happier lives, or even lives more useful; and I am not sure, as far as B is concerned, whether a change from St. James's to the land of the Southern Cross would be a success for him or anybody.

But there are many, very many, Anglo-Indians who have not these resources (if I may speak of resources in this connection), and who—whether from want of means or absence of inclination—hunt not, play not cards, and, in short, do nothing but get up and tub, and have meals and read the paper, and go to bed again; there is, in fact, no reason, except the hygienic one of air and exercise, why they should get up at all, so little is the consequence of their uprising to themselves or anybody else. Their physical energies are stunted by their cramped environments. Their intellectual force, with all its possibilities for good, is a power wasted; and this is so, albeit a wide field is open to them in Australasia for the employment of that time and that capacity which here run to waste.

This subject has recently attracted some attention in India, and some practical steps have been taken to obtain authentic information about it. In the *Times of India* of the 7th September, 1892, a long notice is given of practical inquiries made in South Australia, from which I proceed to quote some valuable particulars.

"The project of founding an Anglo-Indian colony in South Australia," says the *Times of India*, "has occupied recent and serious attention in that part of Australia. A Board of Advice and Correspondence has been constituted under the presidentship of Sir Samuel Davenport, K.C.M.G., to afford all possible information to Anglo-Indians who wish to satisfy themselves as to the desirability of South Australia as a place of settlement."

It notices that Mr. J. T. Christie, C.I.E., has visited that colony, addressed audiences there, and reported the results in a pamphlet that has attracted much attention, and proceeds to quote Mr. Christie:—"Mr. Christie summarises the needs of Anglo-Indians under three heads. In the first place, they want con-

genial occupation for themselves, safe investments for their capital, and the prospect of a profitable career for their sons; secondly, a climate free from the enervating influence of India, and the equally depressing effects of English east winds and fogs; and, thirdly, educational facilities, within easy reach, for the benefit of the younger branches of the family." All these desiderata Mr. Christie finds presented in South Australia.

"There are plenty of safe opportunities for employing capital in the city of Adelaide," he says, "at considerably better rates of interest than are obtainable in England, while in the country the conditions of life are almost idyllic. The garden, the orchard, the vineyard, the dairy farm—all these and kindred occupations seem to offer a happy life and a remunerative investment."

The climate is pronounced to be all that can be desired. In the northern territory—the tropical or sub-tropical land, suited to the growth of sugar, rice, wheat, indigo, &c., and cultivable only by coloured labour—"the air is dry, bright, and bracing; in winter the nights are cold and not unfrequently frosty, but the days are usually sunny, and the weather at the coldest time of the year is very similar to that of Naples and along the Mediterranean coast generally in the month of October. In the southern districts the climatic conditions are not unlike those of Algiers."

"With regard to education," says my authority, "South Australia is exceptionally favoured. Primary education is free and compulsory, with permissive Bible teaching. Higher education costs from £12 to £20 per annum; there are advanced schools for girls, State schools for both sexes, a technical school, an agricultural college, and, finally, a university whose degrees are duly recognised in Europe. Churches of all denominations are plentiful though there is no State church, and there is no lack, therefore, of facilities for religious instruction. There are also numerous institutes, reading-rooms, and libraries subsidised by the State."

"The picture," he continues, "is just as rosy so far as health statistics are concerned, the death-rate per thousand standing at 11·1 as against 17·9 for England and Wales."

"As to the house and household," he goes on, "£600 will buy a six-roomed stone or brick-built house in Adelaide or its suburbs, together with a quarter acre of ground, or £800 an eight-roomed house; or rental may be estimated at seven or eight per cent. on the capital value. Bread, vegetables, and groceries are cheap, fish and game are abundant, mutton costs 3d. to 5d. a pound, and beef 5d. to 8d. Indeed, the only cloud over the household is the domestic servant. The Anglo-Indian lady, accustomed to a retinue of native servants, must be prepared for much self-help and personal discharge of household work. The colonial domestic, like the American 'help,' is costly, independent, and often somewhat rough and fond of change. The wages of a general servant range from 8s. to 12s. per week."

"Such then," concludes the Editor, "is the Austral Paradise offered on easy terms to the Anglo-Indian, whose family and purse reconcile themselves but illy to the expense of a household at home. The picture is a pleasant one, and there is no reason, so far as we know, to think that it is overdrawn."

I have quoted from the *Times of India* thus copiously, because I find there independent evidence that largely corroborates the views I shall place before you. What is said above as to the educational advantages of South Australia is equally applicable to all the colonies of Australasia, except the big Cinderella of the group—Western Australia. In the other colonies of Australia, in Tasmania and in New Zealand, are to be found excellent systems of State education, good grammar schools and colleges, whereat a superior education is imparted; ladies' colleges and schools of an advanced order for girls, universities, institutes, reading-rooms, and public libraries subsidised by the State. In several colonies there are agricultural and technical schools. So, what is said above as to the possibility of investing capital at a better rate of interest than is obtainable in England, as to the idyllic country life and the cost of living may be accepted as descriptive of Australasia generally as it is of South Australia in particular. But the high standard of health as shown by statistics is shared with South Australia by Tasmania and New Zealand only, while the description of the South Australian climate, which is accurate enough for the Australian continent from end to end, is only correct as to the extreme north of New Zealand, and incorrect for the whole of Tasmania.

As an Anglo-Indian, who has advanced beyond theory into practice, I will add my testimony based on ten years' experience. First, let me briefly suggest some of the occupations upon which our Anglo-Indian may embark in Australasia, often with profit of a pecuniary nature, and, at least, with advantage

in adding to the sum of his happiness. If possessed of capital to the extent of £5,000 to £10,000, he might take up a sheep or cattle run in Australia, and out of this small beginning build up a fortune, or, at any rate, a largely-increased estate and more numerous flocks and herds; or he might engage in agriculture or viticulture on the Australian continent, or with that capital he might find a suitable scene of operations in the world of commerce. But these involve risks from droughts and trade fluctuations that may bid the Anglo-Indian pause, and they might involve also the investment of more capital than the Anglo-Indian would have at his disposal for this purpose.

More prudent, and equally effectual as a means of occupation, would be the investment of some few hundreds in a small property of 50 or 60 acres, to be cultivated as orchard and agricultural farm. There would be plenty to do in looking after such an estate as this, and suitable duties and responsibilities would grow up as the "new chum" became settled—functions connected with local government, possibly a seat in the Legislature. And the £5,000 capital, if he had it, could fructify, producing on mortgage, at 6 per cent. (with excellent security), £300 a year, or enough for a moderate family with moderate wants to live upon comfortably.

Pardon me if I obtrude my own experiences at this point by way of example. I went to Tasmania in 1879 with the full intention of becoming a farmer, not because I knew anything whatever about agricultural matters, but because I believed there was nothing much in them to learn. I bought a small place of 50 acres, with a cottage, a garden, an orchard, and so many dead gum trees (to say nothing of stumps) upon it that they shut in my view by day and haunted my dreams at night. And while I was yet wrestling with this timber and my potato planting, I was elected a member of the Devon Agricultural Society's Council, my peculiar qualification for which was an entirely novel view of farming. Then, early in 1879, I became president of the local town-hall and public library, and member of the district school board. In July of that year I was elected member of the House of Assembly for the district, and a J.P. for the territory. So, within fourteen months of my arrival in the colony, I found myself up to the eyes in work—legislative, judicial, parochial, and horticultural; so fully employed, indeed, that I had to abandon my agricultural pursuits, except the removal of those defunct eucalypts, and confine my outdoor employment to stump-grubbing, tree-burning, and the care of my garden.

That garden in itself was all-sufficient to me. For months together I have spent all the daylight hours in it, save an occasional excursion to occupy the magisterial bench, or sit upon some district board or committee. All the year through that garden had its charms of colour and perfume to lavish upon me; always there were life and growth in progress, and new delights unfolding themselves out of nature's bounteous lap. I can honestly say that this work among my flowers and shrubs and trees would have satisfied me with existence had I had no other occupation whatever to take me from them; and many an Anglo-Indian would, I am convinced, feel as I do, if he led that sort of life. I can add, with equal honesty, that my ten years in Tasmania, fully occupied, as they were, by these various labours, were the happiest that I have known.

Dean Hole, in the delightful book that he has recently published, makes the following remarks upon the joys of the gardener :—

"It is the man or the woman who strikes the cutting and sows the seed, who tends and trains and waters, protects from the frost and screens from the heat, who watches the lateral break out of the stem, the formation of the foliage and the bud, who tastes the full felicities which flowers bestow. You may buy flowers, pay others to grow them for you, and admire them when they are grown ; but if this is the extent of your affection, you miss, and deserve to miss, three-fourths of the pleasure which is given to those who cultivate and care for the plant."

I endorse every word of this. I knew every inch of my two acres of garden by heart, and had my heart very much in every inch. Every bloom and every burgeon was a friend—my monster pelargoniums, that stood from 3 to 4½ feet in height, and had a circumference of 9 to 27 feet, were sources of increasing pride and pleasure to me, as they were of successive glories of flower. My fruit trees and vegetable garden yielded a never-failing supply of food for the table that in England, purchased of the greengrocer, would have cost me about £100 a year.

Many another garden like unto mine is there in Tasmania and New Zealand, gardens in which all the fruits and flowers of the temperate zone flourish abundantly, and in which it is possible for a European to work all the year round without fear of sunstroke or frostbite. In Australia, where the heat is greater,

the gardening conditions are less inviting to the European amateur. There, even in the south, sub-tropical fruits and flowers thrive under a blazing sun, and as one goes northwards towards the Gulf of Carpentaria, the cactus, hibiscus, oleander, bamboo, banana, and many another specimen of Indian flora fill the places that in Tasmania are occupied by the hawthorn, the dog-rose, the apple tree, and the other growths familiar to us in English gardens and hedge-rows.

Now, I have dealt with this matter at some length because this Tasmanian or New Zealand garden (which furnishes at once occupation, pleasure, and profit) contrasts so very favourably with any apology for it in India or England.

In India there are many prudent Anglo-Indians who do not keep up their garden if they have one. They keep a *mallee*. They keep a *mallee* even if they have no scrap of ground for him to dig and delve in. And that *mallee* brings the daily supply of flowers and vegetables from somewhere—he does not say whence they come, the master is not inquisitive, and so the diurnal *dallee* comes in, and the gardener's retention in the establishment is justified.

Where there is some show of keeping up a garden in India, how do matters stand? The *mallee* crawls about the beds and paths, sitting on his heels to work, and doing very much what seems good to him, though that which he does would seem bad or indifferent to an employer who took any interest in his proceedings. In the rains bull-frogs oust the *mallee* from his territory, and rank, but unbeautiful, vegetation springs up to become a breeding-house and shelter for insects that after nightfall swarm into the lamps, and the soup, and the sherry, and everywhere else that exploration is possible to them and annoying to the householder. In the cold weather there is a brief season of flower that is brought to an untimely close by the hot sun and drying winds of March. Then, after even the portulacas have given in, a season of heat that parches almost everything; and then the bull-frogs again, and so on *da capo*. I believe there are a few, very few, enthusiasts who, equipped with sun-hats and gig umbrellas, double-lined, steal out, even when the sun is some way up in the heavens, to graft, and bud, and snip off withered blooms and so forth. These are the exceptions.

The above remarks apply to the gardens of Northern India. In the south, where there is less of dry scorching heat and much more moisture, vegetation has a twelve months' tenure; but there the bull frog has a longer term of occupation, and the rank growth of the rainy season harbours an occasional cobra, as well as noxious winged things. Mr. Phil Robinson has written delightfully about his Indian garden, so has the author of "The Tribes on my Frontier," but both dilate much on the animal life, and very little on the vegetation of their gardens.

And what is an English garden? For six months or so, a study in neutral tint—flowerless; leafless, save as to a few evergreen shrubs, whose clothed condition only accentuates the barenness of the deciduous trees; its beds and borders naked patches of earth; its lawns and walks occupied only by the worms that have escaped the beak of thrush or blackbird. How is one to make a thing of beauty and joy for ever out of a garden that for six months out of the twelve is very little superior to a London back-yard? I have attempted to make my half-acre of Surrey some sort of substitute for my two acres in Tasmania, but with little or no success. In June I bed out geraniums and other plants—not plants that I have reared from cuttings, and which are old friends that cost me nothing, but new ones, bought of some nurseryman—that begin to think seriously of flowering in July or August, and are cut down by frost in October, to be uprooted and carried off as rubbish. From my Tasmanian garden a barrowload of roses, pelargoniums, chrysanthemums, &c., may be carried off without any impression being made; if a single rose were taken from my Surrey garden it would be missed, not because of its merit, but because it was one of so few. The growth of vegetables I do not attempt, because I am assured that I could not rear cabbages at less than 2s. 6d. each, or peas at anything under a guinea a peck. In short, while my Tasmanian garden keeps me to a great extent, I entirely keep my Surrey garden without deriving anything like the same pleasure and occupation from it. And in Australasia much more is to be made out of orchard and garden than the most lavish supply of fruit, flowers, and vegetables for the household, and the conversion of one's home into a bower of roses. Fruit may be grown for the markets of the world, as are now, to some extent, the apples of Tasmania, and the more tropical products of the Renmark and Mildura irrigation colonies. But even in Tasmania, where all fruits of the temperate zone grow

with a profusion and in a perfection unknown in England outside the hothouse—where also the cultivation of apples has advanced by leaps and bounds—even there much remains to be done for the realisation of maximum results from orchards. Apricots, and many other fruits that now are largely wasted, might be shipped to England in the cool chambers of ocean-going steamers and placed in the London market in March or April, when buyers would pay for them almost as if they were hothouse-grown. As it is, and when the orchardist turns his attention to little beyond apple growing and the raising of other fruits for the local market only, substantial profits are realised.

The explanation of this difference is our superior climate, or mainly that, if, as is no doubt the case, greater fertility of soil be in many instances a disposing cause. In Tasmania, with the exception of the west coast, we do not experience excesses of either heat or cold or rain. It is never as cold there as it is in England, snow, save on the higher hills, being something phenomenal; it is never so oppressively hot as it is in England; the air is drier, clearer, and more exhilarating than it is here; fogs, after the manner of the London particular, are unknown, and if on occasion a mist comes down a river valley or creeps up from the sea, it is only local and temporary in its character. In every season of the year outdoor occupation is thoroughly enjoyable, and when the days are coldest there is ordinarily a bright blue sky overhead, out of which glows a genial sun that cannot be recognised as that sickly planet which at rare intervals, and for a few minutes at a time, emerges out of the English winter murk. I have known winter days there that would have been suitably used for cricket matches, and no summer day that was too hot for them. There are Tasmanians who rarely, or never, wear an overcoat. There are many, many days in Tasmania when one feels that the mere living in that climate is a joy. And as the climate is in Tasmania, so in a great degree is it in the central portion of New Zealand. Northern New Zealand, running up to 34° north latitude (or 6° beyond Tasmania), is warmer, Southern New Zealand, extending to 47° south (or 3° below Tasmania), is colder, but between 40° and 44° south (the latitude of Tasmania), New Zealand has much the same climate as Tasmania. Partly for climatic reasons, New Zealand has attracted more retired Anglo-Indian officers than any other colony of Australia; or 42 against 31 in Tasmania, and 49 for the five colonies of Australia, the total pensions paid in 1890-91 to civil and military officers, widows and children of such officers and non-commissioned officers, soldiers and their widows, being £15,168 in New Zealand, £10,501 in Tasmania, and £15,680 for the five colonies of Australia. (See Appendix A.)

I have excepted the west coast of Tasmania in the above remarks because it has a climate of its own. Very much more mountainous is it than the rest of the island, and its many hills, often clad with forest to the crest, present a front to the prevailing wind that comes upon them over the wide sweep of the Southern Ocean. Rain clouds are stopped by those western ranges, and squeezed so thoroughly, that the registered rainfall on that coast is three or four times that of the eastern or central districts. It is, in fact, uncomfortably wet there, and as the altitude of Mount Bischoff and other localities where settlement has taken place is from 1,200 to 2,000 feet above sea-level, the climate is sensibly colder there. But as this west coast is almost exclusively given up to mining for gold and silver and tin, it is hardly probable that Anglo-Indians should be attracted to it save as casual visitors.

Surely a climate such as I have briefly described is better suited to the Anglo-Indian who has spent half a life-time in India than any he can find in England—even, I would venture to say, than any he can find in Europe by spending the life of a nomad in moving from one region to another as the sun approaches or declines away from the meridian. Such a climate would put new life into him, and a new power of enjoying life if it did not altogether rejuvenate him. It would effect this without exposing him to the rigours of that English bracing air—say the bleak sea-breezes of the East Coast—which, however beneficial to the hardy Norseman, would possibly chill the very marrow of the Anglo-Indian. It would not subject him to a violent contrast, such as that afforded by the cold *douche* or plunge after a Turkish bath; nor would he have to dread an enervating or relaxing climate in any season or locality, as he must in many countries of Europe and certainly in England.

Statistics, as trustworthy as statistics ever are, show very clearly the healthful condition and longevity of the people of Tasmania, New Zealand, South Australia, and other parts of Australasia. The longevity of Tasmanians

(not all of them pensioners, who are bound to drag out existence) has become almost a by-word, and it was recently illustrated by a newspaper paragraph to the following effect:—"An aged couple, of respectively 90 and 95 years, were found on board a steamer bound for Melbourne from Launceston (Tasmania's second city and chief northern port), and were asked why, at their advanced time of life, they were travelling to the continent. 'Because we cannot die in Tasmania,' was the reply."

And this life, wholesome in every way, is, in Tasmania and New Zealand, lived amidst the most picturesque environments. Nowhere in the world is there such wealth and variety of beautiful scenery as are to be found in Tasmania, within easy reach of the resident in that colony. I say this without hesitation, and in face of my belief that, within the four corners of Great Britain, there are many exquisite scenes that cannot be greatly excelled in any part of the world. But we have, in Tasmania, all that is admirable in the physical features of Great Britain (save only, as an omnipresent feature, the lovely foliage of England's indigenous trees) and a great deal more. In many of the longer settled districts, where oak, and elm, and pines, and poplar have superseded the eucalypts, dogwood, and sassafras, the country presents the appearance of rural England as it is seen in Berks or Kent; there the roads meander between hedgerows of hawthorn, furze, and dog-rose, and here and there, by the way, are comfortable homesteads nestling amidst orchards of apple, pear, cherry, and other English trees; at intervals occur the wayside inn or rustic village, the squire's mansion with its wide lawns and paddocks, the church upon the hill, perhaps an old windmill lingering yet, although the brawling stream hard by finds power for the miller of to-day, as well as trout for the fisherman who can lure them with his fly. He who travels thereaway sees nothing to disabuse his mind of the idea that he is still in England. Something after this style, and peculiarly Kentish, is New Norfolk, the land of orchards and hop-gardens, but one approaches New Norfolk by the valley of the Derwent—a river that, flowing between hills of infinite beauty of form and colour, has all the charms of the Rhine except the ruins and beetling crags, and many charms peculiar to itself. In the lake districts, on the table-land of the western tiers, there are lakes fairly comparable with Como, or Killarney or Loch Katrine. On the west coast there is mountain scenery of wild but glorious beauty. All round the island are coast views varying in character, but mostly of great charm; here like unto the rough wave-swept cliffs of Cornwall, there to the shores of the Bay of Naples lapped by an azure sea. One gets in Tasmania even the loveliness of tropical vegetation without the heat of the tropics. The fern-tree gullies realise this to the full. Hobart, lying at the foot of Mount Wellington and looking out from its gardens upon the estuary of the Derwent and away beyond to Mount Direction and other hills, is, I should think, the most beautiful capital in the world; its suburbs are worthy of it; and the drives and walks in the neighbourhood—to the fern tree bower and springs on Mount Wellington, or to Brown's River, and the beach and blowhole close by—have attractions that do not pall even on the oldest inhabitant. Launceston has its special beauties of hill and stream to look out upon and enjoy, and its tourist places such as Corra Lynn and the Devil's Punch Bowl; and, finally, it may be said of nearly every locality that it has these natural advantages in a greater or lesser degree.

And my point is that several beautiful scenes essentially differing in their aspects are often easily accessible from the locality in which one chances to find oneself—that there is no monotony to surfeit one of nature's splendid pictures. My Tasmanian home, that is perched on a hill, 300 feet in height, overlooking Bass Straits, is an example of this. From my garden or from a paddock close at hand, I command not a single picture, but a gallery, of which I never weary. Even when I am gardening it is possible to me, without any poignant regret, to pause in my enthralling and somewhat back-aching employment, to look round upon sea, and hill and valley. North is a stretch of sun-lit sea of infinite variety of colour, azure and opal, and amber and purple, and green, over which now and anon pass the light cloud shadows. Turning to N.W. by W., I have that same sea breaking upon the yellow sands that stretch by many bays and promontories away to the distant Table Cape, where it is lost in a golden or purple haze. Looking out from the back of my barn across the estuary of the Forth, and away over wooded hills to the Dial range, I have a view (especially at sunset) that the lake country of England can only equal. Then southward, I command the valley of the Forth, the winding river flowing in the foreground through corn-field and orchard and disappearing in a gorge

timbered to the water's edge; and away in the distance tier upon tier until Mount Roland and the Black Bluff mountains (snow-capped in winter both) close in the scene. And if nature, in her grander moods, suggest the want of something more homely, I can turn eastward and look over a long stretch of farm-land, orchard, and homestead, which is quite English, although rather more undulating and somewhat less timbered than England.

And even the above long list does not exhaust my scenery, for the sea is not always sunlit. Though mostly it smiles, sparkles and is gay, it has its days of gloom and anger, when the foam-crested waves break wildly upon the beach, and the deep tints of indigo and purple are only relieved by the white of the foam and the green in the curl of the wave before it breaks. That view I get from the beach (about half a mile off), where I breathe ozone and face the gale on those days of storm, and where I fall asleep, lulled by the lapping waters, on the sunny days.

That beach and many another like it are almost in themselves sufficient attractions to a settler who loves nature, or cares for a breezy gallop or a picnic. Beaches there are that stretch for 20 miles or so; beaches of firm sand upon which the people ride and drive and run their races; beaches where children may gather shells by the hundred, sea-urchins, sponges, and brighter roses for the little cheeks that in Tasmania are, with rare exception, sufficiently ruddy.

New Zealand has scenery not more beautiful, but sometimes grander, than that of Tasmania. New Zealand hills or mountains are higher (12,000 feet, as against 5,000 in Tasmania); she possesses more of those interesting features that come of volcanic action, and the *flora* of her woods is richer than that of Tasmania, if only because of the many varieties of pittosporum that grow wild there, and nowhere else, as far as I am aware. I should say that New Zealand's physical characteristics are more virile than those of Tasmania; but, as a Tasmanian, I can put up with more feminine surroundings in consideration of the absence of those volcanic eruptions to which New Zealand has more recently been subjected.

There are in Australia, here and there—on the Blue Mountains, near Sydney, for example—scenes that bear comparison with those of Tasmania and New Zealand. But this is not the rule; and I am sure that the thousands of Australians who flock to Tasmania in the summer to escape from the heat of their own colony will admit that, as they find improvement in Tasmania's climate, so do they in her scenery.

Then, as the *Times of India* has it, living is cheaper in Australasia than in England; very much cheaper, if we take into consideration the smaller cost of necessaries, the smaller requirements, and the relative costlessness of some things that here are luxuries. Meat costs about half what it does in England, and, in some places, less than half. Dairy produce, bacon, ham, poultry, eggs, honey, fruit, and fish are, generally speaking, to be had at prices below the English rates, and most of them, besides vegetables, to be had by the owner of a few acres of farm and garden for nothing but the labour of a man who will serve as gardener, farm-hand, and groom, and possibly earn his wages and keep out of a dozen acres well put down in potatoes. Even the sanitation of a small holding may be turned to profitable account, for the kitchen refuse, that servants are apt to throw out anywhere to fester and breed abomination, saved for the pigsty will, with the orchard windfalls, and unmarketable potatoes, and butter-milk, feed up two or three infant slips, that cost 6s. to 10s. each, into noble pigs that will furnish pork, and hams, and bacon, for the year.

As to imported goods, English hosiery, millinery, and other perishable articles of the kind, that have to be renewed from time to time, seeing that these bear heavy import duties, it might naturally be expected that they would cost much more than in England—that, in fact, they would cost the English price with freight, agents' charges, duty, and the colonial dealers' profit added—but that is not the case. The explanation being, in my opinion, this—that as we, out there, are six months behind the season here, our tradesmen can afford to wait for their goods of each season until that season in England is terminated by clearance sales; and, buying their stocks at greatly reduced prices, these providers of antipodean raiment, and so forth, are able to sell them at something like London prices. Then, too, we have not that inflation of values that fashion gives here, whereby the article valued at 2s. 6d. in the Strand pretends to be worth 5s. in Bond-street.

This absence of fashion, or display, or pretension, is very marked in some parts of the colonies, and notably so in Hobart, where there is a society largely composed, like those of Christchurch, Auckland, and Nelson in New

Zealand, of the families and descendants of retired officers, Anglo-Indians, and people of modest but independent means. In Hobart reasonable gaiety, hospitality, and sociability exist always. Dances, walking-parties, picnics, concerts, comedy or opera bouffe at the Theatre Royal, amateur performances at the Bijou, and pleasant club functions (including an admirable rubber) keep the place alive; and lest gaiety should grow into levity, these proceedings are tempered by an occasional oratorio by the orchestral union, or a meeting by some sedate body, such as the Royal Society, for the reading and discussion of some solid paper about sun-spots, or a newly-discovered crustacean, or some kindred subject dear to the scientist.

But albeit Hobartians are thus given to gregarious revelry, there is a laudable moderation about their methods of enjoying themselves. Men do not invite each other to a dinner that is provided by some local Whiteley, and served by strange waiters who are wound up like so many automata to pass the viands and wines regardless of the guests' requirements, and in whom there is no chord that answers to the touch of their temporary employer. Men there ask their friends to dine (generally at 1 or 1.30 p.m.) without pretending that their *ménage* is other than it is, and no one thinks the worse of them if they do not provide champagne or hot-house grapes or green peas at a guinea a quart. There are but few of those protracted and painful banquets that the Anglo-Indian generally loathes as the *burra khana*. And similar simplicity, with the handmaid comfort, attends the other Hobartian entertainments. The theatre is cheap (ordinarily 3s. to the best place in the house); concerts rarely (*i.e.*, only when some star of magnitude, such as Hallé and Madame Neruda, appears) run into more than 2s., and may often be negotiated for 1s.; the club whist points are 2s. 6d.; and, lastly, the ladies who are in the first rank of the *beau monde* think nothing of tripping on foot over the clean pavement to an evening entertainment, even to a swagger ball. This simplicity of living extends to dress. The Tasmanian woman is proverbial for her beauty, and if I could believe her conscious of this possession, I should imagine that she trusts too fully to that natural charm to seek the adventitious aid of millinery.

This simplicity of living in a community, which does not ruin itself to keep up appearances, affords an additional reason why money goes much further there than here. There one has fewer demands upon one's purse for unnecessaries, and is spared some considerable expenditure without suffering any pangs of self-denial by way of equivalent.

I wish I had kept accounts to show the exact cost of my living during the ten years I spent in Tasmania. I only know that for less than £500 a year we lived, during some of those years, a family of three to six, exclusive of two servants, or from five to eight all told; that we denied ourselves nothing that we much wanted, except the Koh-i-noor and other diamonds, which my wife desired then, and still desires, in vain; and that we kept four or five horses during that time.

Certainly, the keep of our horses did not cost us much: for eight months of the year they ran day and night in the paddocks, and their feed cost nothing; for the other four months they were stabled at night, and fed night and morning with oats, bran, oaten hay, and chaffed oat straw. Their keep and the farriers' charges ran into something like £10 each in the year.

And now I am going to join issue with the *Times of India* in regard to domestics. As far as concerns Tasmania, my experience has shown me that the general servants of whom Mr. Christie speaks are not specially costly, independent, or rough, although they are, like English servants, sometimes fond of change. We had servants there, respectable and self-respecting daughters of farmers, who cost us less than English servants at lower wages, because it cost so much less to keep them, and there were no ridiculous extras such as beer-money; they were better mannered and educated than the average British domestic, and no more independent than one would wish an honest, self-respecting servant to be. And I may add that, after we had acquired colonial experience and some sort of reputation as employers, we suffered little inconvenience from want of good servants.

No doubt there was considerable difficulty in this respect some few years ago. Lady Barker, in her sketches of New Zealand life, graphically describes her own servantless condition in days long passed: and even to-day, despite the energetic efforts of the British Women's Emigration Aid Society to supply the colonies with trained domestics, there are occasional instances of the lady of the house becoming her own cook or housemaid, or even general servant. But even when this befalls, the glorious climate gives the housewife the necessary energy and strength for her work,

and compensates for that retinue of servants to which, if an Anglo-Indian, she has been accustomed.

Very little white labour is, in my opinion, required to console one for the loss of that dusky crowd which divides household duties into such minute parts that no individual member of the establishment has occupation anything like sufficient to employ the hours when he is not asleep. And, unfortunately, the unemployed hours of the Indian domestic are not devoted to what, according to Western ideas, may be called improvement; not a few of them are devoted to such close and persistent study of the mendacious art as shall enable him to break the Ananias record. Macaulay styled Nuncoomar the acme of liars; what would he have thought of the kitmutghar who, immediately under your observation, smashes a decanter, and then says, without demur or blush "api tootgia" (it broke itself)?

Rather than these soft-footed, glib-tongued perjurers, give me the Tasmanian Phyllis of bright and honest eye and rosy cheek and gracious smile, even though her footfall be audible some few yards off, and her hand, deft with the broom or saucepan, descend too forcibly upon the china. Or give me the Tasmanian Strephon who cheerily does for me the work of one gwala, one moorgiwalla, two bheesties, three mallees, four syces, four grass cuts and five chuprassies, or twenty of that Indian retinue by which such store is set by some.

The difficulty is to convince Anglo-Indians generally upon this point. I was myself convinced easily enough by a series of letters written by Captain Low of the B.C. (now Sir Robert Low) for the *Pioneer*. Those letters gave a graphic description of his experiences as a Tasmanian landowner, and satisfied me so completely as to the desirability of settling in that colony that I did so straight away, and I have never for one moment regretted it. Would, for their sakes, that I could induce others to follow my example.

But, even when I have almost persuaded them that Tasmania (which is without a single aboriginal inhabitant) is not exclusively populated by black men, obstacles are protruded. (1) They say, "Ah, we cannot go so far from our home ties"! and (2) "We cannot leave this country, in which there are such superior means of culture, intellectual enjoyment, and so forth—such advantages in art and science, and sport, and social life."

With the first objection it is impossible to reason. The attachment to home ties is a respectable sentiment, but one cannot argue against a sentiment, respectable or otherwise, any more than one can against a dislike for tobacco. It must, however, suggest itself to any ordinary thinker that it does not lie in the mouth of an Anglo-Indian to say very much about those ties for, unhappily, their severance is the most ordinary incident of Anglo-Indian life. The grass widows, who adorn the hill stations of the Himalaya and the Neilgherries by hundreds, have left their home ties in the sweltering plains. The wives, and mothers, and children who come home for health or education by other hundreds, leave behind the husbands and fathers, who toil that their dear ones may live, and slave away until their children know them only as a memory—a very precious memory often, but one that has not that value in the home life which is peculiar to personal and day to day intercommunication, And, finally, what is the position of the Anglo-Indian who comes home to settle after 20 or 25 years' separation from his English connections? He finds that he has very much ceased to have any part in their lives as have they in his. Half a life-time has gone by since the thread of their acquaintance was broken and nothing now shall repair that breach. Their talk is of, their interests are centred in, people and events of whom and which he knows and cares nothing; and, as for his talk and interests, they are as Dead Sea fruit to those shadows of a generation that is gone; to them his best tiger story is but a twice-told tale that fails in the first telling—the narrative of his 30 years in the East flat, stale, and unprofitable as the history of Sandford and Merton.

But the other objection is distinctly arguable, and is, I believe, for the majority of Anglo-Indians, a purely imaginary one. I admit at once that here in London there are means of intellectual improvement, art, study, and general entertainment, that are unrivalled, as to scope, and excellent as to quality. But these advantages of the metropolis avail nothing to the man who is buried in Bath or Cheltenham, or some less known country place, and but little to him who, living in London, cannot afford to indulge in expensive pleasures. The best music in the world, vocal and instrumental, is to be heard in London, as well as the worst; but opera and first-class concert tickets cost more money than an Anglo-Indian family of slender means could often spend upon them, and the members of that family would hear much more of the

music of the street (the barrel-organ, the discordant German band, and the errand boys' shrill pipe), than of the high-class melody of Covent-garden or St. James's-hall. In Australasia that family would be able to enjoy what music was going; and, let me say, that Australasia is strong in native musical talent, and worthy of being the birthplace of such children as Madame Melba, Amy Sherwin and others who have won distinction on the lyric stage of Europe.

Then there are in London 40 theatres and a dozen or two music-halls, at which, by paying, you may see Irving or Chevalier, or any other British star. But even here, as regards theatres of the first-class, tickets are expensive luxuries for rare enjoyment. In Australasia, on the other hand, the theatres, as well as the concerts, are much cheaper, and there are quite enough theatres for our needs —theatres that, in Melbourne, Sydney, and elsewhere, vie with London houses in size and splendour; and theatres, moreover, where may be seen excellent acting and an occasional European star, such as Madame Bernhardt, if not a Lottie Collins.

London has its annual exhibition at Burlington - house, and those of the water - colour painters and others, and these cost visitors only a shilling a head; and there is the splendid National Gallery. Australasia has her art galleries, fairly good ones that contain many works by leading Europeans as well as by native artists. These galleries are State property and admission is free.

London has the finest museum in the world, but this does not attract any great number of people, notwithstanding its magnificent library. The British Museum cannot be deemed indispensable to the Anglo-Indian, who would find throughout Australasia similar institutions that, already of very respectable pretensions, are growing in interest and instructing capacity every day.

Then, again, there are scientific societies, beginning with the Royal and ending with that still-born abortion of Art, Literature, and Science, the promoters whereof were recently run in by *Truth*; and at the meetings of these societies papers are read and eminently instructive discussions heard. But even if the Anglo-Indian hanker after these, he will find something after their kind in Australasia. So he will find very creditable public libraries, technical schools, schools of mines, agriculture, music, and painting, even though he find not any institution quite comparable with the South Kensington School of Art and Design. In short, in the whole range of culture, it may be said that Australasia treads upon the heels of the mother country, and indeed, now and again, runs ahead and shows the way. This is a point that is very far from being understood.

But, says the Anglo-Indian of the metropolis, or suburban London, "Even if I do not take advantage of all these things, there are other attractions that fix me here. There is our local society that gives my girls an occasional opportunity of dancing; there is the club at which I can freshen myself up by mixing with men, or playing a rubber, or a game of billiards." He will not be persuaded that these attractions exist at the antipodes; that as a fact, there is much more in the way of gaiety, including every form of dance, from the ball in a palatial town-hall, to the carpet hop, in Hobart and elsewhere in those Austral provinces, than is accessible to him and his here. And for clubs, he need lack nothing in any of these colonies. I have been in those of Sydney, Melbourne, Adelaide, Hobart, and Launceston, and can speak of their excellence; I have played whist in some of them, and can pronounce that excellent also.

In this imaginary argument that I am holding with my brother Anglo-Indian of the town, he will certainly at some stage put in the plea that here he is at the fountain-head of English literature, the source of much knowledge, and the centre of all. But telegraphy and steam have destroyed—have, at any rate, largely impaired—England's monopoly of these good things. The new book that a London publisher brings out to fascinate, or bewilder, or scandalise the English world is in Australasia within six weeks of its appearance at Mudie's; so it is with the song that becomes the vogue, or the play that holds the stage here. The latest utterance about Home Rule, the domestic occurrences affecting personages, the last fluctuation of the money-market, to-day's murder and yesterday's elopement, appear in Australasian papers twenty-four hours after their publication here; and, *per contra*, news of Australasian doings arrives in England even before (according to nominal time) the doing has been done. Another evidence of Australasian briskness.

Nor, in that far-off land under the Southern Cross, need he be without his morning paper —a paper excellently got up, and frequently of much cleverness—wherein, if there be local matter new to him in his early colonial life,

there will always be ample news of the old world that he has left. In short, he will find himself out there still within the pale of civilisation—in a world of considerable culture and much aptitude in art—and, above all, in a community more English than any in the world outside England.

And now for the Anglo-Indian of the country who snatches brief occasional joy from some form of British sport, and so breaks, to some extent, the monotony of rural life. For him the racecourse, the hunting-field, the stubble, the covert, and the trout-stream—or some of them—have attractions; but, alas, attractions that, as to shooting and hunting, are very costly. Those Anglo-Indians who can afford to keep up a stud, or rent or buy a shooting, are a small minority. Those who can often afford, as guests, the tips and other expenses of a big shoot are not a majority of Anglo-Indians. Mostly, I take it, they have to satisfy their longing for *shikar* by such sport as they can get out of a few acres of rough shooting, carrying, say, a total of fifty head of game, chiefly rabbits; or, now and again they may follow, *longo intervallo*, the local hounds upon a hired mount; or they may whip the neighbouring stream, to come home heavy-hearted, but light as to their creel; or they may find contentment in golf.

They can enjoy all these things in Australasia, and do so at little cost. Horses, of excellent quality, are to be had there for much less than English prices, the cost of keeping them is infinitesimally small by comparison, and there is in Australia the kangaroo for quarry, and in Tasmania the stag, the kangaroo, and hare. As to shooting, no expensive licence is required, and where permission is necessary to shoot over a property, that is readily accorded by the landowner, who shares with Australasians generally the quality of hospitality.

There is, it is true, little or none of that game preserving and battue massacre that obtain in England. You cannot, out there, stand at the corner of a wood and kill while you stand 60 or 70 pheasants driven up to you for slaughter; the game to be got there is reared after a natural fashion, and not as a keeper and barn-door hen arrange; and is dispersed over stubble and copse as the instincts of the birds direct. But pheasants are to be shot in New Zealand (into which colony alone they have been successfully introduced), together with quail in abundance, and deer. In Tasmania (to which partridges have just been sent out for acclimatisation) quail are plentiful, both the ordinary stubble or gray quail of Europe and India, and a larger and darker coloured variety, peculiar, I believe, to the garden colony, and there are snipe, and duck, and hares, and deer. Hares, indeed, have, in some localities, become a pest like unto rabbits. In Australia, there are snipe, ducks, and bustard. And in nearly all the colonies there are kangaroo, wallaby, and far too many rabbits.

Splendid fresh-water fishing is to be had in several colonies of Australasia. Salmon, salmon trout, trout, and a grayling, locally known as the herring or cucumber mullet, abound in the perennial streams and lakes of Tasmania. There are on view in the Tasmanian Court of the Imperial Institute eleven specimens of trout from the Great Lake, weighing from 13 lbs. to 25 lbs. and averaging $17\frac{1}{2}$ lbs., that testify to the size of our fish at any rate.

New Zealand also has succeeded in acclimatising the trout. Fish of over 20 lbs. weight have been taken, and baskets of 40 to 50 lbs. are recorded as of common occurrence.

According to some experts (Sir Thomas Brady and others), Tasmania has the true salmon in her rivers; she has at any rate a good imitation of that fish in the Derwent and Huon, the late Governor, Sir Robert Hamilton, having taken one in the latter stream that scaled $27\frac{1}{2}$ lbs. But perhaps the best fishing in Tasmania is that of the small northern rivers, where 10 to 20 dozen graylings (locally known as herrings) may be taken by a single rod with fly and gentle.

The trout has also been introduced into Victoria, and a recent report states that it is thriving in the Yarra. Then in the Murray (the river boundary that divides Victoria from New South Wales) there is the Murray cod dear to the disciple of Isaac Walton.

And if fishing be combined with yachting there are many wide stretches of Australasian waters in which the colonist may disport himself. Nowhere in the world can the yachtsman find a place better suited to his purpose than the estuary of the Derwent or Port Jackson. Cowes, doubtless, has a larger show of boats than Hobart; but, even now, the lovely harbour of the Derwent and the broad stream for miles seaward from the capital are gay with sail and pennant of many a trim-built weather-board.

For the oarsman, the sculler, the footballer, and the cricketer there is a splendid field in

which he may vie with some of the salt of the athletic earth. He may see there cricketers who have played successfully against the best teams of England; and he will find in New South Wales the champion sculler of the world.

For him who loves racing there are meetings in every important centre of population, from the splendid gatherings at Randwick and Remington to the amateur contests near some country town. There is Melbourne's great Olympian carnival, when society, with its biggest capital S and its most gorgeous raiment, congregates from far and near to see the cup race of the year. Elsewhere fashionable revels of the sort, at which the fields engaged and the equipages round the course, and the dresses and beauty of the dressed, quite come up to the standard of Epsom or Doncaster.

Having thus hastily sketched such attractions of Australasia as occur to me, let me turn to one of Mr. Christie's desiderata, as to which nothing is said in that *Times of India* article which is in a way my text. This is the prospect of a profitable career for the sons of Anglo-Indian settlers. This is a point often mooted to me, and I have only one unvarying reply to give, which is this. There are, for the sons of Australasian settlers, at any rate, better prospects of making a career in the colony than present themselves in respect of an English career; there is a wider field there; there are more frequent openings and opportunities; but it is often necessary that the young man who seeks his fortune there shall be satisfied with a humble beginning and always ready and willing to take his coat off for his work. Clerkships in banks and merchants' offices are to be had occasionally, and are not sought by as many candidates there as here. There are situations as overseers, managers, and stockriders to be had, when a little interest backs up the candidate's application; there are at least as good chances there as here for him who graduates in law or medicine. But, more than all, the young fellow who will devote himself to agriculture or orcharding in New Zealand or Tasmania, if he have capacity, thew and sinew, perseverance, and a small amount of capital to start with, may do even better than the youth who wins his way to the black-coated servitude of a bank. My experience justifies me in speaking hopefully on this subject, for, within a year or so of my arrival in Tasmania, I placed two sons satisfactorily, and without having any particular interest or capital to secure a start for them.

Similarly my colonial career warrants my speaking very hopefully of the Anglo-Indian's chance of obtaining work to do, even legislative work, if his mind incline that way, and legislative work, moreover, that must give him from £100 to £300 a year as an independent member, and may give him much more, as has happened in my case. Three Anglo-Indians have stood for seats in the Tasmanian Parliament, and always with success.

Let me summarise. I ask Anglo-Indians to consider whether Australasia should not suit them better than England as a scene for their retirement because of the following advantages offered to them there:—(1), a better climate; (2), living so much cheaper that luxuries here unattainable may be enjoyed out there; (3), a chance—in some colonies the certainty—of obtaining congenial and sometimes remunerative occupation; (4), a field for more profitable investment of capital; and (5), a wider field for the career of sons. And I do not ask my fellow Anglo-Indian to seek these good things in a savage or heathen land, but in a country essentially English, amidst a people who are kindly to a degree, and in a society that is adorned by all the graces of civilisation.

Better, I say, be in a new world where a man may become something and something do, than in the old one, where there is nothing for him to achieve save living to draw his pension and curse the decline of the rupee.

DISCUSSION.

Mr. W. B. Perceval (Agent-General for New Zealand) said he was not an Anglo-Indian, but a colonist born and bred, and, for the most part, educated in the colony of New Zealand, which he now represented here, and which was one of the fairest and most prosperous portions of the British Empire. One difficulty Sir Edward Braddon had had to contend with in his paper was the large field he had to travel over. The term "Australasia" hardly conveyed to anyone who had not studied a map, or spent some considerable time in travelling over that part of the world, a correct idea of the enormous area which it comprised, and very likely that would explain the differences of opinion which existed on many aspects of colonial life. Australasia was larger than Europe, and embraced New Zealand, although that colony was 1,200 miles away from Australia, and had an altogether different climate, different fauna and flora, different soil, and a people with different characteristics. Yet, men in this country did not realise this, and often

APPENDIX A.

ABSTRACT TAKEN FROM THE ACCOUNTS OF THE STAFF OFFICERS OF PENSIONERS IN THE COLONIES FOR THE YEAR ENDED 31ST MARCH, 1891.

THE FOLLOWING AMOUNTS WERE PAID WITHIN THAT YEAR.

	Civil and Military Officers.				Widows and Children of Civil and Military Officers.				Non-commissioned Officers, Soldiers, and Widows.				Total.			
	No.	Amount.			No.	Amount.			No.	Amount.			No.	Amount.		
		£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
New Zealand......	42 ..	10,053	16	8	40 ..	4,911	15	3	11 ..	202	8	10	93 ..	15,168	0	9
Tasmania	31 ..	8,843	14	8	13 ..	1,604	11	7	6 ..	53	13	4	50 ..	10,501	19	7
Queensland	7 ..	1,229	6	1	8 ..	326	6	6	5 ..	95	18	0	20 ..	1,651	10	7
South Australia....	3 ..	956	16	6	9 ..	652	6	2	7 ..	155	19	0	19 ..	1,765	1	8
Victoria	27 ..	6,241	15	10	13 ..	1,289	3	5	13 ..	216	17	11	53 ..	7,747	17	2
New South Wales..	12 ..	2,054	16	3	27 ..	2,033	3	11	16 ..	244	0	5	55 ..	4,332	0	7
West Australia	—	—			—	—			12 ..	184	3	8	12 ..	184	3	8
	122 ..	29,380	6	0	110 ..	10,817	6	10	70 ..	1,153	1	2	302 ..	41,350	14	0

(Signed) THOMAS W. KEITH,
Accountant-General.

India Office,
4th February, 1893.

talked of New Zealand as if it were a suburb of Melbourne. So much was this the case that he really believed that the failure of a Sydney bank, or any wave of depression which swept over any portion of the Australasian colonies, had as much effect on New Zealand stocks and interests as it had on the colony concerned. Coming back to the paper, Sir Edward Braddon had presented a very accurate view of colonial life, and one which must, he thought, be considered attractive. Having had experience of both, he felt satisfied that a man of small means, with a large family, could do much better with his money in the colonies than he could in England. He found his house bills in England were considerably larger than they were in the colonies, although he lived in a very modest syle. Servants, perhaps, were dearer in the colony, but they did more work, and you did not require so many of them, and the extra amount which you had to pay for house rent was more than compensated for by the cheapness of living. The statements he had made to this effect sometime ago having been challenged, he had gone into the relative cost of living in New Zealand and in England with some care, and the more he did so the more satisfied he was of the truth of his statement. The good things which were to be enjoyed in this country were really confined to the few, and were not participated in by very many, and a man, with an income of from £500 to £1,500 a year, could get very much more value for his money in the colonies than in England. It must be remembered that time advances very rapidly, and the colonies were not now what they were 40 years ago; then, no doubt, people had to rough it, but now they were able to enjoy every privilege of civilisation. In all the chief colonial towns, life was surrounded by as many enjoyments and comforts as in England, and he did think that gentlemen who had been actively engaged in the early part of their lives would find more scope for their energy and talents there than here, and they would certainly find that the colonists would welcome them, and gladly make use of those possessing such valuable knowledge and experience. Those who cared to embark in agriculture would have a good opening before them, and although they might not all possess the necessary qualifications to make successful farmers —and he would hardly advise them to take to farming without previous experience— yet, those who had sufficient energy left for the work, would be able to turn the remaining years of their life to profitable account. Sir Edward had quoted from an article in the "Asiatic Quarterly Review," a decription given of colonial life with regard to servants

and so on, which was certainly incorrect, but the writer might have been referring to a portion of Australasia where those conditions existed. Australasia was, as he had stated, very large, and there was a great variety, not only of climate, but of degrees of civilisation—a variety as great as on any other portion of the globe extending over such a large area. The views of New Zealand, which had been exhibited, unfortunately, did not give an accurate idea of the scenery. They were very proud of their colony, and he was quite satisfied that it would compare favourably with any portion of the world. They were also proud of their English instincts, and of belonging to the British Empire, and they hoped to remain a portion of it, and to continue as prosperous and contented as they were at present. If any of those present ever went to reside there, they would not find the picture Sir Edward had painted in any way overcoloured.

Lord Stanley of Alderley congratulated the author on one of the most useful papers he had ever listened to. Although things had altered a good deal of late years, there were still a number of retired Anglo-Indians who must lead very dull lives in this country. They now left India earlier than they used to do, and came back in the full prime of life, with brown beards and nothing to do. This paper opened up to them a prospect of pleasant and useful occupation in Australasia. He did not quite know why the author dwelt so much more on the material advantages they would find in Australia and New Zealand and on the educational advantages and the climate, which would be so much better for them than the damp of this country, while he referred but little to the use they would be there. He did not wish to hurt the susceptibilities of the colonists, but he felt that a man of culture, such as an Indian civil servant ought to be, would be a very useful element in improving the minds of the people of Australia. They might possibly find some useful posts in the administration, or assist in the press of the large towns, and also add very much to the enjoyment of the members of the clubs which they would join.

Sir Raymond West, K.C.I.E., said, in responding to the invitation of the Chairman, that he had no authority to speak on this subject; he had not seen any of the colonies, and was rather inclined to take up the part of *advocatus diaboli*. The reason that our countrymen preferred coming to England, Ireland, and Scotland, rather than to any other country, when they retired from the service, was the sweet home associations of their early childhood, which hung about them all their lives in India. There was the centre of their past life, there they had lived in their families, and there their own children had been brought up. Their affections, therefore, would ever turn homewards; and even colonists themselves—many of them after a long career in Australia and New Zealand—found themselves drawn by an irresistible attraction, as the evening of life drew on, towards the same place to which their infant footsteps strayed. This feeling could not be got over by the material advantages of any colony, nor could any colony—unless it were the source and origin of the men who governed the Indian Empire and took part in its administration—ever have, for the mass of Anglo-Indians, the irresistible attraction which England and the United Kingdom had. At the same time, for people with families, the openings in the colonies were certainly better than in Great Britain. Yet withal it must be borne in mind that a man who went there from England or from India, from India especially, plunged into an unknown world. He had not around him the same set of old associations which he had in England. To give an instance, his valued friend, the late General Ballard, who was well known probably to many there, having a family, when retiring from India, took the trouble of making a tour of the colonies, with the view of determining whether he could better plant himself as a retired officer there or in England, and he came back with the fixed conclusion that, upon the whole, if a man had some capital he could buy a share for a son in some professional business in this country, or could set him up as an agriculturist, with almost, if not quite, the same chance of success that he would have in the colonies under their existing conditions; and that, therefore, no one should go out to the colonies with the idea that, with less labour, or less capital, he was going to make a fortune there which he could not at home. He should think the evidence of a man so sagacious, and with so wide an experience as General Ballard ought to weigh very much, and that people should not be led into the idea that they could get on and succeed without a great deal of labour and expenditure of capital, probably at some risk, in the colonies. Another circumstance which told against the colonies, as he had learnt from correspondents, was that they found themselves plunged into a society, the tone of which was absolutely different to what they had been accustomed to. The people they came in contact with had their own ideas, associations, and interests, and the prevailing tone was wholly diverse from the semi-military tone which prevailed all over India, and which affected very considerably the class they were considering. For a man who had spent his whole time in a particular social atmosphere, this change was exceedingly trying, so much so that when Anglo Indians came back even to this country they were apt to herd together almost like a flock of sheep, and found themselves more or less out of harmony with the great mass of society in England, in the midst of which they were sometimes looked upon rather as bores for a considerable time, until they had acquired a new set of interests by residence, and the revival of old acquaintances and associations. Of course, these considerations were not conclusive against going to the

colonies, but they should be borne in mind, and any who had these sensibilities in a peculiarly strong degree would probably make a mistake if they sought their happiness in going where those sensibilities would be continually trodden upon and offended. It required a certain sturdiness of character and a special set of tastes for a man to succeed in a colony. The matter had to be viewed from both sides, but those who did so, and found on a fair estimate of themselves that they were calculated to succeed would no doubt become most valuable members of the society they joined. Some instances in New Zealand were quite fresh in his memory of men who had gone there, had been received with open arms, and had become most valuable links in the chain of common feeling which ought to bind together every portion of her Majesty's Empire.

Major DE WINTON said it was doubly necessary, after what the last speaker had said, to make a remark from the point of view of an old soldier in the colonies. He could endorse everything Sir Edward Braddon had said with regard to the advantages of living there. He had lived there a great many years. Many officers were settled there, and none of them ever regretted it, whilst many of those who came home and settled here regretted they did not stay there. They had all done well. He had never known one officer who, after leaving the service, embarked in any business or profession in this country who did not come to grief; and, on the other hand, he did not know of one who did not succeed in the colonies.

Mr. W. MARTIN WOOD said that Sir Edward Braddon had referred to the *Times of India*, and quoted from a series of papers which appeared in that journal. When he saw those papers coming forward again, he had a sort of feeling that this was a very old hare, and recalled to his mind the assiduous efforts made by a Bombay officer, Colonel Crawford, many years ago, to establish an Anglo-Indian colony in Tasmania under as favourable circumstances as could be. Never, surely, was more energy put into the matter; but he did not find in this paper any reference to the history of that effort; so it must be that Sir Edward Braddon had found no trace left of that settlement of "Castra." Thirty years had elapsed since then, and great progress had been made in the colonies in every way. Perhaps the social conditions which had been referred to weighed considerably with Anglo-Indians, but it certainly was striking that there should have been that effort made, and that it should have taken no root; for those Anglo-Indians who had gone to the colonies seemed to have done so sporadically, following their individual tastes. This paper, however, was so admirable in its form, and so full in its information, that, if anything could renew that migration from India to Australia, it would certainly accomplish it.

Brigade-Surg. R. PRINGLE said this paper was one of very great interest, pointing out very effectively what an admirable field for Anglo-Indian colonists was to be found in Australasia, and one must see at once that the time was coming when this subject must be brought more and more to the front. The reason for this lay in the fact that now-a-days the value of an Anglo-Indian's life was completely changed from what it was. As a medical officer, he should say it was now worth certainly 10 years more than when he entered the service in 1854. Still, after a long expatriation in India, it was a trial to have to add to re-expatriation the difficulties of beginning *de novo*, and taking root again in a fresh place. There were many questions of detail he should like to have put, if time allowed, but the principal point he wished to emphasise was that an Anglo-Indian, on retirement after 30 years' service, had much more work left in him now than he had 30 years ago.

The CHAIRMAN, in proposing a hearty vote of thanks to Sir Edward Braddon, said that, if time had allowed, he should have offered a few remarks on this interesting subject, suggested, both from his experience in India and in most of the Australian colonies He would, however, only state his thorough conviction of the truth of all the statements made by Sir Edward Braddon, with reference to the success which had more or less attended the civilian servants and soldiers who had come down from India, which he had witnessed over and over again in the Australasian colonies, especially Tasmania, which more perfectly reproduced a type of English life and society perhaps than any other colony, and which was almost altogether founded by officers of the various services. There they had founded families, and met with success and prosperity. He believed in the future many others from the various services would repeat in the other colonies, as well as in Tasmania, the success which had attended the pioneers in this latter.

The vote of thanks having been carried unanimously,

Sir EDWARD BRADDON, in reply, said the most formidable criticism, though of an entirely friendly character, was that of Sir Raymond West, who spoke of home ties, a point which he had practically admitted himself. Home ties were as strong to him as to anyone, but he had to take into consideration, when he left India, whether he should come home here, and live in genteel independence and idleness in a London suburb, or go and push his way in a new country. He loved this country, his fatherland, but not its climate, and he should escape from it as soon as he could; but he loved its associations, and was deeply attached to those who were here; but he found life was very much better to him in Tasmania, though all he held dear amongst English were there only a fondly cherished memory. Sir Raymond

West had said something not too complimentary with regard to the tone of society in the colonies. He (Sir Edward Braddon) had been all his life mixed up with military men; he had lived practically a military life for years and years in cantonments, living and sharing a soldier's life, and, in fact, being practically a soldier, except having to get up early in the morning and go on parade. He had fought side by side with British soldiers, and lived with them; but going straight from India to Tasmania, he found nothing whatever in the society he there mixed with that grated upon his military instincts in the slightest degree. He believed he had been fair and only fair to the colonies His advice to Anglo Indians was purely disinterested, because he regretted to see many of them here wasting forces which might be of infinite service to the colonies, and who, as Mr. Perceval said most distinctly, would be gladly welcomed and appreciated there.

SIXTEENTH ORDINARY MEETING.

Wednesday, April 12, 1893; Francis Cobb, Treasurer of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Barker, Frederic William, 7, Ferndale-road, Sefton-park, Liverpool.
Batten, George Henry Maxwell, 3, Ralston-street, Tedworth-square, S.W.
Martin, Major Gerald Ward, H.M. Assay-office, Mint, Bombay.
Rozario, Louis Charles do, Hongkong.

The following candidates were balloted for and duly elected members of the Society:—

Chatterton, Alfred, College of Engineering, Madras.
Knight, Edgar William, Junior Athenæum Club, W.
Schiller, Frederick William, 205, Brixton-road, S.W.
Simmonds, T. C., Burton-road, Derby.

The paper read was —

THE CONSTRUCTION OF LOCKS AND SAFES.

By Harry W. Chubb, A.M.Inst.C.E.

The subject of old locks and their keys is one which has received a considerable degree of attention, and those which are noticeable chiefly for the beauty of their artistic forms, have taken precedence, being treated popularly from time to time in illustrated periodicals. Modern inventions have also created interest, but interest of a different kind, more utilitarian —in fact, scientific. It need not, however, be taken for granted that the two views are incompatible; or, in other words, that a sharp line must be drawn, say, at the end of the 17th century, to divide the artistic from the mechanical. As a matter of fact, the gradual growth or evolution of the locks in common use to-day can be traced, with but few missing links, from the earliest forms. Overlaying, and sometimes almost obscuring, the mechanical intention, is the work of the artist, this being invariably characteristic of the period when the artist-worker lived. This is true no less of Roman times than when French and German smiths of the middle ages encrusted their lock-plates with Gothic mouldings and carved their delicately-shaped key-bows. As the styles of architecture and its kindred arts succeeded one another, age after age, the decoration and treatment of locks and their keys were affected by the same changes; mechanically, they altered also, not, however, always for the best, when looked at from the modern point of view. One cannot, therefore, say that their advancement in the two respects has been together, but the connection between the two is at all times interesting and often instructive. Mechanical invention, pure and simple, is just as much subject to the general laws of progress as everything else. So also is the work of the designer—mechanician and designer being equally inventors in the true sense of the word. When you have the two qualities combined in one man, as they were frequently in the Middle Ages, you get a result that is self-evident; and although it cannot be said that the progress then in craft equalled the progress in art, there is yet a greater harmony between the two than when they are separated, or in any other way specialised. Whilst the inventive faculty has had, and still has, so much to do with the locksmith's craft, this is hardly the opportunity to analyse it; but I think the axiom will be readily granted that, viewed broadly, it is not purely a matter of spontaneous genius or mere mental accident, but is, as I have suggested, a faculty admitting and responding to cultivation.

Before entering upon the subject proper of this paper, there is one minor branch that may be mentioned. I refer to the use of seals. The effect of the seal is an ethical one—as long as the moral tone of the community is good. The Egyptian store-house keeper sealed up his

large earthenware corn jars, using clay as the material to take the imprint of his matrix. One notable Biblical instance occurs when Darius and his lords sealed the door of Daniel's den. No lock was needed where the king's device had been impressed, and the king alone could undo his own work. The survival of sealing to the present day, for securing our Post-office despatches and Customs vaults, shows that where there is an obvious intention on the part of authority that certain things shall be left alone, that wish is respected. The use of a personal or corporate device, first and still employed as a means of identification and of legal power, readily lends itself to this purpose.

Amongst early fastenings, those intricately made by knotted thongs or ropes should not be omitted, for with these nomad pastoralists tied up their tents. The Gordian knot will, of course, occur to everyone in this connection.

No one has more clearly traced the early growth and sequence of lock mechanism from the primeval door bar than Lieut.-General Pitt-Rivers. Doing for locks what he has done for weapons, for certain conventional designs, &c., his contribution to their history is of great value. Besides tracing their development, he has followed the various types along the known lines of early trade, showing how they became distributed.

The present wooden lock of Egypt—the Dub'beh—supposed on fair grounds to be the same as that used 4,000 years ago, has been illustrated and described so often that it is almost needless to do so again. That the two locks are identical is highly probable: the water - raising "shadoof" has remained through this long period, and there are other evidences of similar mechanical crystallisations in the East. Indeed, a recent description of a wall painting in the temple at Abydos, given by the late Miss Edwards, almost proves the point. She writes of "Rameses II. . . . . in the act of opening the door of a shrine by means of a golden key formed like a human hand and arm." This closely agrees with the oft-quoted account—now 100 years old—given by M. Denon, of a painting in the great temple at Karnak, and both descriptions are true of the present day lock and key.

It is quite reasonable to suppose that the first barring of a door was done by means of a cross beam, either dropped into sockets or sliding in staples fixed on the door; and it is equally reasonable to suppose that if it slid, a vertical pin dropping into a hole through the staple and beam together, kept the beam in place.

If the beam was *inside* the door, and had to be released in order to slide it back, then one kind of key was necessary to take out the pin; of this I shall speak presently. But if the beam was on the *outside*, then the locking pin must be hidden, and can only be reached either through a hole in the beam, or else through a hole in the staple. The Egyptians adopted the former method; other primitive peoples adopted the latter. They — the Egyptians—shortened the beam into a long bolt, and made it hollow for part of its length, so as to reach the pin, hidden in beam and staple through the beam itself. The key, which was pushed up the hollow, had pegs on it to match the pins which held the bolt—for the one pin was now multiplied. When the key was well "home," it was raised, and so its pegs lifted up the pins out of the way, leaving the bolt free. Then the bolt was drawn back by the key, the pegs of the latter filling up and engaging with the holes till then filled by the pins. You notice the shank of the key is the arm, the pegs are the fingers of the hand. We shall see how this principle of dropping pins—true tumblers—was adopted with variations by the Romans.

Now, as to another class of primitive locks, those in which the pins were reached through a hole in the staple and not through the bolt. There is good reason to believe they were once remarkably widespread, though now chiefly found on the fringes of culture. You see them at the present day in some parts of Scandinavia, in the Hebrides and Faroe Islands, and the peasant of Normandy still makes them for his gates and barns. They have also been observed upon the West Coast of Africa; and Herr Andreas Dillinger, of Vienna, whose name is known in Germany in connection with the historical study of locks, states they are in use in the less frequented parts of Galicia, Roumania, and Servia. The hole in the staple by which to get at the pins is a horizontal one above the bolt. The pins are square in section, and are notched on their sides for the key to pass, and get into position before being lifted. The key is usually flattish, with little side projections which engage the pins. After they are lifted, it is necessary to pull back the bolt by hand, thus making a marked and essential difference between this lock and that of Egypt, in which the bolt is withdrawn by the key itself. They vary in detail, some having

two sets of pins, the key passing between the sets; in others the pins have holes right through them for the key, not merely side notches.

The next two classes of primitive locks are those in which the beam or bolt was mounted on the inside surface of the door. In this case, if fastened by the tumbler pin, it would not be so necessary to conceal it as when both were outside the door. There are some curious sickle-shaped pieces of iron found now and again, which look as if they were made for the purpose of putting through a hole in the door, and pulling up or pushing up the pin. Perhaps they simply engaged the bolt in a direct fashion, and, being turned from the outside, moved it to and fro. But they vary in their outlines too much for this supposition to be probable, some being full sickle-shape, and others only slightly cranked or bent, and in some well-preserved specimens their ends have been carefully shaped, as if to fit a hole exactly. They have been found at many places in France and Germany. General Pitt-Rivers well authenticates some he himself found near Lewes, to the late Celtic period. In connection with these he also discovered some coins cast in tin, of debased Greek design, and points out how this shape of key agrees precisely with a description given by the Greek writer, Eustathius, in the 12th century, who states that this kind, although still in use, were considered antique. This coincidence is extremely curious and interesting, and makes one wonder if the Phœnicians had been the agents of its distribution.

At last we come to the fourth primitive type of lock, the bolt or beam being still inside the door. In this type the bolt was kept out by the projection of a spring or springs, which spread out against the side of the staple in the same way that an unwilling boy spreads out his arms and legs against the jambs of a doorway through which his schoolfellows try to push him. The first function of the key is to compress the springs. It is a flattish one, with return prongs or hooks on its end. It is first passed through a horizontal slit in door and bolt; then turned a quarter-circle, and pulled. The pull brings the prongs to bear upon the springs of the bolt, making them lie flat, and so clear of the fixed obstructions at their ends. The bolt is then free to slide back, and this is effected by simply sliding back the key, for its prongs are now embedded in the bolt. The keys of these locks are numerously found among Roman remains, and locks of this kind are stated to be in use still in Norway.

Having thus very briefly stated what is known of the primitive kinds of locks, let me take the last type, and show how closely allied its mechanism is to that of the Roman padlock. Looking at the diagram, you will see the lock consisted of two parts—a body, and what, for want of a more accurate term, may be called a hasp, or bolt. The hasp carries on its lower side a pair of spreading springs, and these enter a hole in the end of the body when the two pieces are being put together. When the hasp is pressed right "home," the springs, which, during the operation have been gradually closed up, now fly out inside the body, and so hold the two parts together. To take them apart the springs must be compressed, and this is done by the key, which is pushed through a hole in the body against their sides near the point, and slides along them. The springs are simply flexible barbs.

It is no wonder that loose, portable locks, like those used to secure baggage of all kinds in transit, should become well known and distributed, especially along the ancient lines of trade. But as this style of padlock is found to be the almost universal one now in China, one is tempted to ask who was the first and true inventor, Roman or Celestial? They are seen, too, all over the East, being shaped and decorated in ways peculiar to their own countries. Here I have a modern Japanese of dragon-shape, two others with hidden keyholes, and a fourth—Chinese—in form of a conventionalised dog. His tail turns up right over his body, and goes through the back of his head, its end forming the tongue; this is the hasp. To release it, the key enters a hole in his chest, and you push the tail right out. There are some bodies of Roman ones in the British Museum like this Chinese curiosity, but looking more like horses than dogs. All these have the diverging springs. There is one in the Indian Museum in which, to close up the springs, the key is turned as in an ordinary padlock of the present day, not simply pushed in, and a large class of mediæval padlocks—French ones more especially—are made like this. The Romans had other kinds of padlocks as well, the security parts of which were made like those of their fixed locks. Here is a copy of one made from an original at Pompeii.

Now as to the Roman fixed locks. Many archæological "finds" indicate what these

were, but none so clearly as those unearthed at Pompeii. I will show you on the screen some specimens photographed by a friend for me in the Naples Museum, and you will see from these, as well as from the wall diagram, how closely these locks are akin to the Egyptian. The bolt is now much shortened, and is concealed behind a front plate; it is still held, when locked out, by vertical pins falling down into it. The parts are now mostly, if not all, of metal, sometimes in a wooden casing or block. The pins vary in sectional shapes, being oblong, square, and triangular, as well as round, and are pressed down by a flat spring. The key has projections or teeth formed on it, corresponding to the pins, and reaches the bolt through a hole in the front plate. The pins being pressed up by the key projections, the bolt is free, and can slide to and fro, precisely as in the Egyptian lock. Roman keys are found much more commonly than their locks, and some are of such shapes that it is not always easy to say what their locks were like. There is a key with its "bit" angle shaped; one angle is cut to operate bolt pins in the way just now described, the other is pierced with holes, as if to pass fixed obstructions or wards. Many of the keys were undoubtedly turning ones, having solid stems called "pins," or else made with hollow stems called "pipes." The pipes were sometimes drilled right up, so that any dirt or other obstruction could be pushed through. I believe this simple device appears in three separate English patents, and not a year passes without some enthusiastic inventor re-discovering it, and offering to part with his idea for a consideration. Here are two old bronze keys of this kind, dug up in London. On the wall is a picture of one taken from Molina's "De clavibus veterum." This picture brings us to a class of Roman keys that is quite unique, and which, although well suited to present wants, is, strange to say, not in demand. These are the keys attached to finger rings. Whilst not found as numerously as those of other types, you cannot visit an antiquarian museum without seeing specimens of them. Their bits are as diverse as those of the larger keys. Here are five specimens on one of the show boards. These are replicas cleverly made after originals at Naples. A few only are found combining signets with keys on one and the same ring. It was the Roman wife to whom, as a bride, when crossing the threshold of her new home, the house keys were given. They were all hers, with one exception. That exception was the key that kept the wine. This her husband held. The hoops of the ring keys are all large, being of a size suitable for a masculine finger, and it is likely that they may have been specially for the locks that secured the wine amphoræ. Just now I suggested that it was a pity this combination of ring and key is seldom met with in general use. Many years' personal experience has shown me that it is an extremely convenient combination. The key folding behind the signet of this ring opens

FIG. 1.

KEY, FOLDING BEHIND SIGNET (Modern).

several locks *en suite*; there is less chance of losing it than if on a chain, and its effect upon Customs officers—even on a New York examiner—when produced to open trunks and bags, is marvellous.

Here let me mention what there is bearing upon our subject among the objects recently found at Silchester, Hants. There are quite a number of iron hook keys of various sizes, with their prongs arranged in different ways; there is the iron hasp with barbed springs of a padlock, a bolt in bronze for a fixed lock, with perforations for triangular pins (this in very good preservation), and there are two of the neat little finger ring keys.

Coming down to the Byzantine period, one has to regret the absence of information about locks and keys. One need not wonder at this. "The empire preserved much, but did not add to the treasures of civilisation" (Garnett). In gold and silver work the Greeks still excelled, and the golden lions by the side of the throne of Alexius Comnenus, that sprang up and growled, no less than the mimic forest with automatic birds behind the throne, attest their mechanical skill. In all probability the existing forms of locks and keys, as regards mechanism, at any rate, were adhered to.

I will now show you a few transparencies on the screen prepared from photographs of objects in the museum in Naples, very kindly taken for me by a friend. These will exhibit the characteristics of the Pompeian work.

About the shapes and ornamentation of the key shafts there is no light Greek touch, such as you find breathing through the higher forms

FIG. 2

POMPEIAN KEY (Naples Museum).

of Roman art; still they have an interest of their own, and have not been previously illustrated.

At last, in the 7th century, and in the now more settled West, a metal-working personality appears, St. Eloy. He was probably the first to found what would now be called a "laboratory of art metal;" and this was in connection with his abbey. Three centuries later comes St. Dunstan, in early life working at the forge himself, and even later, when burdened with the heaviest cares of the State, still, at his leisure, fostering the growth of art in metal. Other great men, long since those times, have found relaxation in the blacksmith's art. I recently came across an old jingle, in which of Louis XIII. it is said—

> "Sometimes into his forge he goes,
> And there he puffs and there he blows,
> And makes both locks and keys."

This is said of him when he was young. Charles I. indulged his caprices in the same direction, and, later yet, Louis XVI.

With the commencement of the Mediæval period, we get to shapes of keys more like our own, and working more like them than the preceding types. The sliding and pushing have given place entirely to turning movements, the keys being either made pipe-fashion, to slide on to a fixed pin in the lock, or else made solid, and terminating in the projecting pin, which fitted a socket or hole cut in the back plate of the lock. Later on, the section of the pipe was not always circular, sometimes it was triangular, and the pin on which it was pushed was shaped to fit it. Of course, provision was then made for the pin itself to turn with the key. The outside of the key, too, was fluted, and the lock pin then became a barrel as well, revolving in bearings at both ends. But this is anticipating, for these varieties do not appear until Renaissance times.

One feels greatly tempted at this point to make an excursion into the wider field of metal-work in general, for it was then that the smiths' art began to take shape and prominence. Our study is but a small branch of the art not being specialised till modern times, and it is somewhat of a barbarism to strip off a lockplate from, say, a cathedral door, and show it alone. Unaccompanied by the graceful curves of the hinge straps that flow across the door to it, a good deal of charm is lost. With the introduction of the pointed style in the 12th century, the culture of iron-work, no less than of the other metals, begins to move side by side with architecture. The Church, becoming richer from her share in the world's increasing wealth, secures not only the services of the best laymen, but increases—especially in France—the number of her monastery schools in which the arts were variously taught. From these emerged many a masterpiece in iron, silver, and gold, fashioned by hands that were guided not more by art feeling than by a love for the sacred edifice the work was to adorn. Besides, there was plenty of time to do what had to be done: lives of hurry were unknown. Even in those days the results were not taken as matters of course. They excited admiration and wonder. Witness for instance the compliment paid to Biscornette, a layman, the maker of the hinge work for the doors of Notre Dame, Paris. They said he could never have produced anything so beautiful without the devil's help.

Perhaps professional jealousy started this rumour, if so, it was all the more a compliment. At any rate he disappeared suddenly one day, and the secret methods he had discovered died with him (Burty).

These very early keys have their humble bows in symbolical, or, speaking generally, in ecclesiastical shapes—trefoils, quartrefoils, and the like. Most remaining to us are of bronze, and, like many of the finely wrought-iron specimens of later date, have thus escaped the melting pot that, from time to time, as coffers got empty, engulfed art work made in the more precious metals. Here is one with an almost spherical bow, pierced. This early lock is the ancestor, in direct and unbroken line, of the ordinary tumbler lock of to-day. It had a bolt prepared by a notch for the key to actuate—locksmiths call this notch a "talon"—and it was held in place by a tumbler. The tumbler, instead of moving vertically, was hinged. The word "catch" describes it better than tumbler. A part of it came down over the bolt to reach the key, and the first thing the key did, as you turned it, was to lift up the catch; then, as you went on turning, the key caught the bolt in its notch and moved it. The wall picture, with the sliding door bolt, is one of these. You will notice the bolt has a hasp or tongue coming off at right angles to it, and this enters the lock, and is there secured by the internal bolt. Liger, I think it is, ascribes these locking bolts to the 13th century. You can see them on the cathedral doors of Chartres, Rouen, and in some of our own cathedrals, and I once met one in a very unexpected place. This was on the door of the inner temple building at Kandy, where the piece of ivory called Buddha's tooth is kept. Presently I will show you a photo of it. The surface decoration of the lock has nothing Gothic in it, and it did not look imported, but no one knew its age. Within the same building was another surprise, the iron grille surrounding the tooth itself being fastened with two Chubb's padlocks!

Besides these 13th century locks with the single tumbler, those with fixed wards were in use, their keys showing numerous and intricate slits and perforations to pass over and around them. Warded locks appear to have been the chief kind used for many centuries. Amongst the primitive we found four types: at this stage we have but two—the letter padlock does not come until the commencement of the 17th century.

Certainly the most beautiful specimens of keys are those we now meet with belonging to the 15th and early 16th centuries. A good specimen authenticated to 1530-1570, and now at Frankfort, is shown in diagram. Others in

FIG. 3.

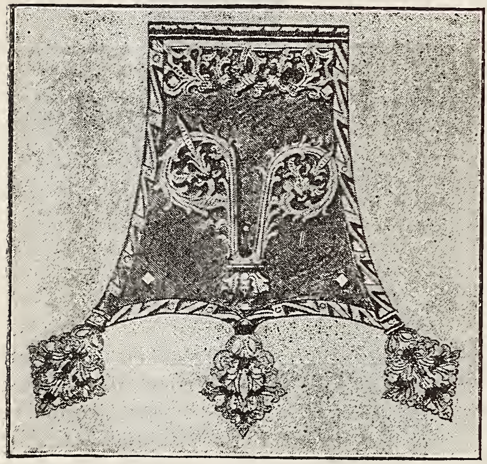
(Florence Museum.)

the Florence Museum I will show on the screen There are a few at South Kensington, and some in the Musée Cluny. For perfect proportion in all their details and minute workmanship, they have never been excelled, even by the later Renaissance keys. Their four-sidedness and breadth gives them a strong sturdy look, but this is lightened by the gracefulness of their pierced tops and sides, allowing the same play of light and shadow that you get through the tracery of a Gothic window. Hence flat pictures alone do not show their beauty; you must see them in order to be able to appreciate them. Of course, they are awkward to hold, and you could pick their locks, but such criticisms are the property only of the 19th century—the century which commenced by making roses, flowers, and branches in cast-iron for suburban villa gates, and has not quite got out of the habit yet. Now, also, we get the highly-ornamental lock plates of French and Flemish make, the Italians devoting themselves chiefly to the adornment of sword-hilts and other articles. The French locks, and even escutcheons, showed considerable skill in adorn-

ment. The mouldings of the traceries upon them are made of layer upon layer of saw-pierced plates, one plate on top of another, their edges forming the members of the miniature mouldings. Where there are no figures or other devices, to which the traceries are only secondary, there is sometimes a background of brass. This gives a contrast in colour, and adds effect, for traceries are primarily intended to be seen by transmitted, and not by reflected light. If by reflected light, then the mouldings must be deep, so as to give rich shadow.

The German work of this period excelled more, from the artistic point of view, in the decoration of their lock plates than in fine keys. To begin with, the outlines of the plates

FIG. 4.



LOCK-PLATE (Augsburg).

are more fanciful. The surface decoration of the plates consists of a single thickness of metal, cut out and embossed, to represent conventional flowers and fruit growing on stems that branch out gracefully from below the keyhole. The converging branches thus form guides by which to find the keyhole on a dark night, or when, from other causes, it was difficult to hit upon it (Wyatt). Recently, this idea of external projecting guides to a keyhole was patented in England. There is an intesting thing about these German lock-plates that partly accounts for their shape. Their bolts were generally spring ones, and, to get long—though not always easy-acting—springs to act upon them, the end of the plate was made much wider, in order to hold and cover them. Hence, you see, there is a direct result of form springing from utility. You can see it in these old German locks I have here, obtained in Nuremburg. On another board is a copy of a Japanese lock-plate of similar shape, but this shape, though common to many Japanese locks, is not, I think, owing to the same cause. One can tell to what extent the Germans prized their pretty plates, when it is known that their owners carried them from place to place to place when changing residence (Labarte).

FIG. 5.

DESIGN BY JOUSSE, 1627.

Renaissance work pure and simple now claims our attention, and we are able to point to some very pronounced specimens, as regards keys especially. A *serrurier*, named Mathurin Jousse, published a book on his trade at Paris in 1627. He discourses on the behaviour of apprentices to their masters, and of their treatment by their masters; tells how he prepares his metal, and how he shapes his

tools; descants on the shapes of padlocks; gives names to multitudinous key-wardings; describes a file-cutting machine, and finishes up with an invalid's wheeling chair, and artificial arms and legs made in sheet iron. The book is fully illustrated, and one of his four keys is reproduced in diagram. Another of his keys is almost exactly like the celebrated Strozzi key from Florence, now in the possession of Baron Adolphe Rothschild, and said to have been made by Benvenuto Cellini; but M. Piot, a French writer of authority, doubts this. Jousse incidentally says that, ordinary padlocks, with spherical bodies (here is one) were easy to make, but, when they had two hasps, and a key going in each side to secure each hasp, they were difficult. Here is an exact copy of one of these, the original being in possession of a friend in Germany. Jousse also says that a lot of time was unnecessarily wasted, through apprentices having to spend so much over their guild work required for initiation. Would that there were some such high standard to be passed now! In Germany, apprentices formally smoked themselves into their guild, using pipes in shape of keys. Jousse's escutcheon plates, whilst, no doubt, true to his times, show classical grotesques painfully conceived, but even they are not as repellent as some of the later German ones. These latter have been illustrated in a series of process photos, lately published at Munich. In these, mere surface scratches do duty for bold incision, and hardly any *repoussé* is used to give force to designs that need it.

In viewing these two periods, the Françaises and Renaissance, we almost lose sight of the mechanism in the art. With the exception of the French letter padlock (about 1615) security seems to have been sought in elaborate arrangements of internal guards or "wards." These previously mentioned were projecting pieces of metal, plates and curved pins, that swept round from the bolt to one side of the keyhole, and were fastened generally in a separate casing or box, hence called "box of wards." The key was shaped to clear them, and so get at the bolt. The bolts being usually "spring," it was not necessary that the key should turn right round, so a good many wards were used that would not have been possible otherwise. Here is one set of wards illustrated in a book published 1767 by Hamel du Monceau. Had the key made a complete, instead of only a partial revolution, it would, of course, cut these wards right off.

The puzzle padlock, as is well known, was improved by a French mechanician, Regnier, at the end of the last century, but this was only one of the many things he did in combination locks. Anyone interested in the details of these will do well to study Bottermann's folio 1781, and may then be surprised to see how little there is new under the sun. When keys were made of irregular shapes in cross-section and passed into their locks through keyholes cut to fit them—that is externally as distinct from being internally warded—there is considerable variety. The most curious one I have met with is illustrated in diagram, and was made for presentation to Napoleon I.

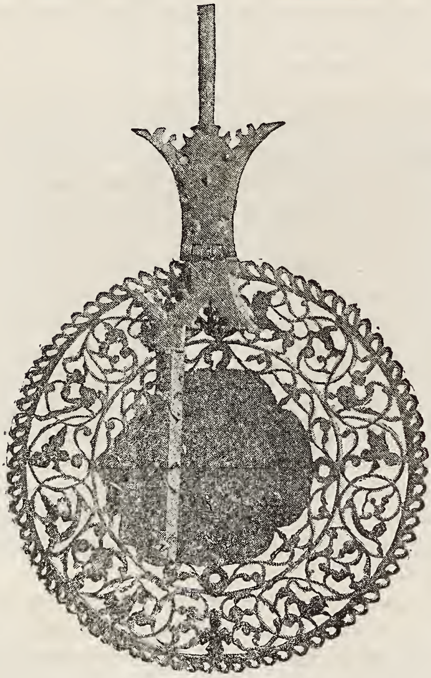
The work done by the English during the Mediæval and Renaissance periods is not as noticeable as that produced on the Continent. South Kensington has one show-case of English locks, and several of French and German. Even the well-known lock-plate on St. George's Chapel, Windsor, is ascribed to Quintin Matsys (Wyatt), and we know that although, at an early date, the grilles around the tombs of Henry III., and of Eleanor, Edward I.'s queen, were done by Englishmen, foreign workers were being constantly invited over, even down to the end of the 17th century, when Tijou designed the gates for Hampton Court Palace. Tijou, by the way, illustrates four perfectly charming key bows. They are delightfully delicate and free in design. But I think to England is due the credit of decorating the stock lock, and certainly the combination of pierced bright or black iron over the strongly marked grain of oak is effective.

To get a good idea of the keys of the last century, one cannot do better than visit the collection of Chamberlain's keys, bequeathed by Mr. Octavius Morgan to the British Museum in 1888. They come from Spain, Portugal, various German States, and Denmark. The times and courts of our own King Georges are well represented amongst these eighty odd specimens. Two unnamed ones are double-ended pipe keys, drilled right through from end to end, and have circular-sliding bows that can be pushed up over either bit to make a handle for the other; they are nearly all gilt, and their bits are in many cases beautifully warded; as for the art of their bows, with the exception of some of the earlier ones, they are decidedly heavy. In at least one of them the emblematic and official idea is so paramount that the key-bit has disappeared altogether, leaving only the bow and

stem; this is but natural, for often disused limbs lose their functions, and in a few generations vanish.

These emblems of office suggest to us the symbolical ideas that have, as it were, hung about keys in all ages, prominent among them being that attaching to the presentation of a key to the Jewish Rabbi on his institution, representing that in future the duty is his of unlocking and exhibiting sacred truths to the people. To those doctors of the law who did not do their duty came the condemnation:—"Woe unto you, lawyers! for ye took away

Fig. 6.



(Birmingham Museum.)

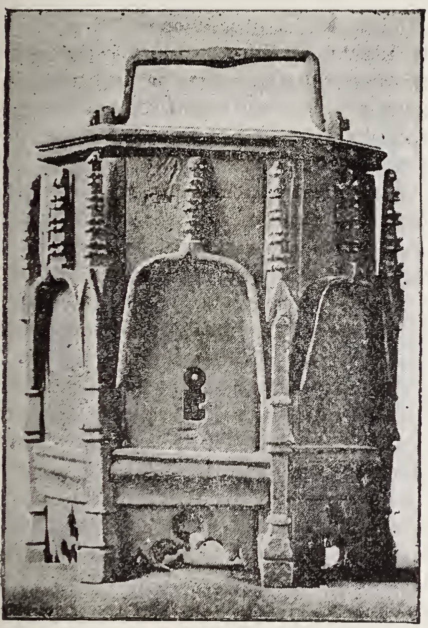
the key of knowledge. . . ." There are many other Scriptural references to the symbolical use of the key as an emblem of power and authority that will at once occur to us. These ideas, too, survive in folk lore and superstitions, keys being used as talismans to prevent the entry of witches into houses, or held by gipsy women when prophesying or fortune telling (Dillinger).

The spirit of applied science that sprang up 100 years ago did not leave locks untouched. First came Barron, so altering and duplicating the old pivoted tumbler, or catch, that it or they had to be lifted to an exact height to free the bolt; and then Bramah, whose ingenuity was as much, or more, displayed in the machines he made to construct his locks as in the locks themselves. Many other names there are of subsequent inventors, all duly chronicled, with their mechanical ideas, in the Patent-office, and more often known to us by this means than by the extent to which their locks have survived. Many inventions have lived for a time, but the Chubb lock, originally patented in 1818, has met with popular and continued appreciation, and now has a stronger vitality than ever. There is always a section in every community that demands things of the highest grade, and to this section the Chubb lock has always appealed. May I here be permitted to state, simply as a matter of fact and without egotism, a curious matter bearing on this point of quality: it has a philological aspect too. In the Straits Settlements the Chinese dealers have introduced a new adjective into their pigeon English; they speak of a "Chubby pair of trousers," or "a Chubby pot of jam," meaning that it is the best of its kind. The Chubb lock first achieved its notoriety chiefly from the fact of its containing a mechanism called the detector, by which the owner could tell if anyone had been lifting up its tumblers too much. This it still has in a slightly different form. Its tumblers vary in number, from six up to ten, according to the size and nature of the lock (a few small sizes have less than six). Contrary to the popular idea that the kinds of Chubb lock are comparatively few in number, the variety is so great that it takes a long experience to master their details.

I will now turn back to the early strong box, for its development into the safe and steel room is so closely connected with locks that the two may, in their modern aspect, be treated together. Dr. Schliemann, in "Troy and its Remains," tells us he thinks he found remnants of King Priam's treasure box, and gives an illustration of its probable key. In the Middle Ages cellars and vaults for storing valuables were protected by wooden doors sheathed with iron plates. Chests were made of oak or other hard wood, often strongly bound with iron bands, and sometimes, as in a beautiful specimen preserved at Knowle-house, Sevenoaks, covered with leather. The German, or so-called Dutch, chests one meets with, made of little iron plates, riveted together under bands, owe their peculiar construction to the fact that large sheets of iron were not produced. The rolling mill was

unknown, and plates and strips had to be simply hammered out. Mounted on the inside of their lids were numerous spring bolts, all worked from one warded central key. Padlocks, too, were often used to secure them. In chests of this kind the goldsmiths of Lombard-street kept their bullion when in the reign of Charles II. London merchants first adopted the banking system. The foundation of the Bank of England, in 1694, marks the commencement of a distinct epoch in the idea of credit that prevailed in England. This idea, permeating every branch of society, has developed with the country's increasing wealth, and is indicated by the present numerous joint-stock and

Fig. 7.

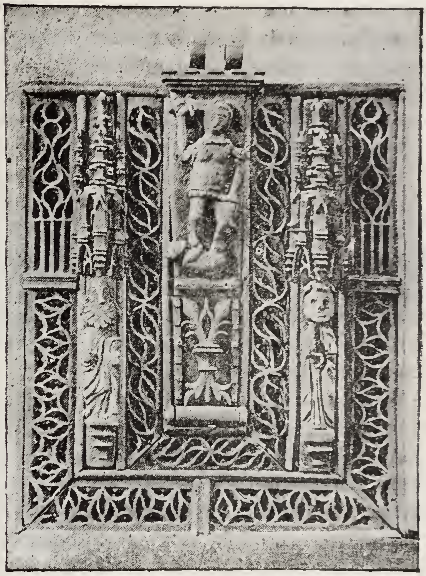


Casket (Florence Museum).

private banks. Cast-iron safes and doors, easily fractured by concussion, were in vogue well into this century, but gave place to those made of rolled iron. This is now in its turn being displaced, the recent strides in the manufacture of that purer form of iron, called steel, having made it possible to substitute this more efficient and reliable material.

It is not my intention to describe in detail the requirements of a good safe, nor to weary you with the difference in quality of the various English makers. My purpose is rather to place before you some particulars of the latest developments here and in America. Despite our advanced civilisation, and the fact of lessening crime, the ingenuity of safe-makers has to be constantly at work to baffle the army of skilful scamps called burglars. Commencing with the productions of American makers, it is necessary to note that they draw a very sharp distinction between safes intended to withstand fire and those to resist burglars. Where a safe is wanted for both risks, a small burglar safe is usually fixed inside one of the other kinds. Anyone, with but little trouble, can force open an American fire safe, and the purchaser is perfectly aware of this. Whilst the outside is made of rolled iron or steel, the inner portion of the door, containing the lock and bolt work, as well as the rebating into which its numerously

Fig. 8.



Casket (Florence Museum).

rebated edge shuts, is generally made of cast iron. These castings are fairly tough, and are not brought through to the outside. The thickness between the inner and outer skins is filled up with materials, selected for their non-conducting qualities. These are probably more various than those used for the same purpose in England, and include hard-setting cement concrete, which gives a certain amount of additional strength to the safe, compositions in a constant state of moisture, mixtures of dry plaster, asbestos, and other finely divided materials. Some commercial salts are often added to the dry mixtures for

the sake of the water of crystallisation which they contain, and which they give off in the form of aqueous vapour when heated in a fire. The Americans, as a rule, make their safes with a greater thickness of fire-proofing than is done here, in order, I presume, to cope with increased risk. Added to this, they often introduce internal sheet-iron doors behind the main doors, entirely covering up the fittings of the safe, or else a layer of sheet-iron, or prepared wood, is fastened to the inside of the main door a little apart from it. Keyless combination locks are used in place of key locks to fasten the main bolts. These, having only one spindle, are operated by a revolving dial on the outer face of the door, the edge of the dial being generally marked off into a hundred divisions. To open the lock, the dial is revolved until the predetermined numbers to which the internal discs of the locks have been set are successively brought to a fixed mark. These discs or wheels, three or four of which are in each lock, are called tumblers—somewhat erroneously in my opinion, for we have already seen what tumblers, whether falling pins or pivoted levers, really are. There is one variety of American combination lock that is a very interesting mechanical study, for its inventor has cut himself adrift completely from the past in designing it. As however it would take too long to describe it, I will simply refer you to the wall diagram, and to a sample of it on the table.

In American safes intended to resist burglars several thicknesses of steel of different degrees of hardness are employed, and all joints between the plates are carefully made, and closed or covered with forged bands. To give extreme hardness, so as to resist drilling, cast metal similar to speigeleisen, and, therefore, capable of being chilled, is in some cases run in between the outer and inner plates of the safe. The strength of some of the United States Safe Deposit Vaults is very great, resulting partly from the emulation of different owners as much as from necessity. One system recently introduced proposes to use solid blocks of chilled iron, grooved, keyed or bolted together, not less than 12 inches thick. Upon the doors of other vaults a good deal of ingenuity is concentrated. One I recently saw in the country of big things is 8 inches thick. This was made not of cast steel or iron, but of rolled plates of varying degrees of hardness, riveted or bolted together. It measured about $7\frac{1}{2}$ feet × 4 feet, and was hung upon crane hinges, shutting into its seating in the front of the vault with numerous rebates and three double grooves and tongues. The fit was so accurate that you could almost cut a sheet of paper between the meeting edges of the door and its surrounding frame. American practice adheres almost universally to the round bolt, made so as to revolve freely, with the idea of thereby frustrating any attempt to saw it through. The bolts are secured by two or more keyless combination locks, and by a chronometer lock, commonly called a "timer," which controls the bolts independently of the others. No doors of safe deposits, bank vaults, or safes of importance, are without "timers," and it is computed that there are not less than from fourteen to fifteen thousand in use. If a burglar, either by force or fraud, obtains the secret of the numbers of the combination locks, he cannot open the safe, provided the "timer" be on guard. The owner, when closing his door for the night, sets his time-lock to run off guard at any hour he selects the following morning, say at nine o'clock, and at that time or after, he can open the door. Timers are all capable of being set to run 72 hours, so as to go over Sundays, or, if necessary, from Saturday to Tuesday. To prevent the possibility of a lock-out, through the failure of springs or other accidents, modern timers have three distinct movements in them, any one of which is strong enough to run the lock off guard should the other two fail. One gentleman, Mr. Holmes, has contrived an ingenious electrical attachment to counteract the effects of a lock-out; another, Mr. Dalton, makes his timer work in conjunction with an auxiliary combination lock, which can only be brought into action when the timer stops. Here is a timer with three movements, which I hope presently to show you at work on the screen by powerful reflection. The existence of the timer, together with the popular reliance placed on it, has enabled the American manufacturers to meet a new method of attack. Discarding drills, blowpipes, gunpowder, and other antique aids to their profession, burglars have, within the last few years, been studying the advantages of nitroglycerine. To introduce it through the door they have pressed or wedged in the spindles, either of the locks or the bolt handles (English makers generally taper these the opposite way, viz., outwards). Though it is not possible to drive the spindle right in, enough space is obtained to inject the yellow fluid. Then, piling books and office furniture in front of the door, they await the blow-up. Of course, this

method, involving as it does some noise, is not well adapted for city operations. What I am saying is not romance. It has been attempted, sometimes successfully, at least twenty-five times. I should be very sorry to think that, by learning such facts as these, any English burglar might be induced to risk his life as well as his liberty, for it is not the duty of any safe maker, with a well-ordered mind, to instruct thieves how to do their work. All I want to do is to show you how this has led up to a new application of the timer. You will see from this method of burglary it became desirable to do away with all spindle holes through the door, and the problem was, then, how to work the main bolts. This has been solved by the use of powerful spiral springs, enclosed in a box mounted inside the door. One set of springs is for throwing the bolts, and there is another for retracting them. When the door is open the springs are wound up, or rather compressed, ready for action. From the nature of the mechanism it is impossible simply to wind up one set without the other. On closing the door, the first set throw out the bolts, either immediately by means of a contact trigger mechanism, or else by a small auxiliary time movement, and the door is locked for the night. The triple timer controls the second set of springs by means of catches, and at the appointed hour next morning releases these, and the main bolts automatically fly back. Thus ordinary locks are quite dispensed with, and reliance is wholly placed in the stored power of the springs, governed by the timer. This arrangement is sometimes applied in duplicate. It might be thought that the catches, being somewhat delicate, could be disarranged by external explosion, but this has been proved to the contrary by experiment. I have heard the objection raised that under this system the bolts, not being always held out by a rigid mechanism, may under certain circumstances be worked or pushed back; but in all work with any pretensions to good quality, it is just as difficult to get at the bolt heads as it is to get through any other part of the safe, or its door. The fact that there are not less than two thousand of these automatic arrangements in use at the present day in the United States shows that they are entirely practical.

In England there is a large variety in the nature of the materials employed for the better class of safe-work. The object, as everyone knows, is to use a material which shall be sufficiently hard to resist drilling or other cutting instrument, and yet at the same time sufficiently tough, so as not to become fractured under percussion or pressure. To the system of running hard metal in between softer plates, may be added that of case hardening, that is, converting into steel the outer surfaces of iron plates of good quality, so largely done now with the working parts of machinery. Plates, or slabs, are also made up upon the model of war ships' armour, *i.e.*, with layers of high carbon steel welded and rolled in between layers of iron or mild steel. The high carbon steel gives the resistance necessary to keep out cutting instruments, the softer material contributing the toughness. Usually and preferably these layers are continuous, so that no part of the structure is unprotected; they are generally five in number, being either three of hard or two of soft, or *vice versa*. If made with two of hard and three of soft, the outer layer of hard steel is covered by one of the soft, but this does not interfere in the least degree with the efficiency of the hard steel, or modify the molecular change that takes place

FIG. 9.

CHUBB'S ARMOUR-PLATE.

in it during the final chilling process. If, however, a hard steel face is desired, it is just as readily made as the other. It is the presence of carbon in steel which makes it hard, and steel with ·6 per cent. of carbon in it is, therefore, more difficult to work than that with the usual per-centage of ·17 to ·18. I mention this degree of carbon—·6 per cent.—because it is a kind of dividing line between steel that is easily worked and that which gives some difficulty—although not by any means insuperable—to hand tools. Safe-makers look with considerable interest upon the experiments of metallurgical experts in the production of steel alloys, so as to obtain a perfectly homogeneous plate, having the two properties of hardness and toughness sufficiently developed for their purposes.

In treating these armour plates in the workshop, I have applied special emery wheel machinery, so as to produce exactly the sizes required after hardening, and thereby obviate the errors of fitting that are unavoidable if the plates be first planed in the ordinary way, and

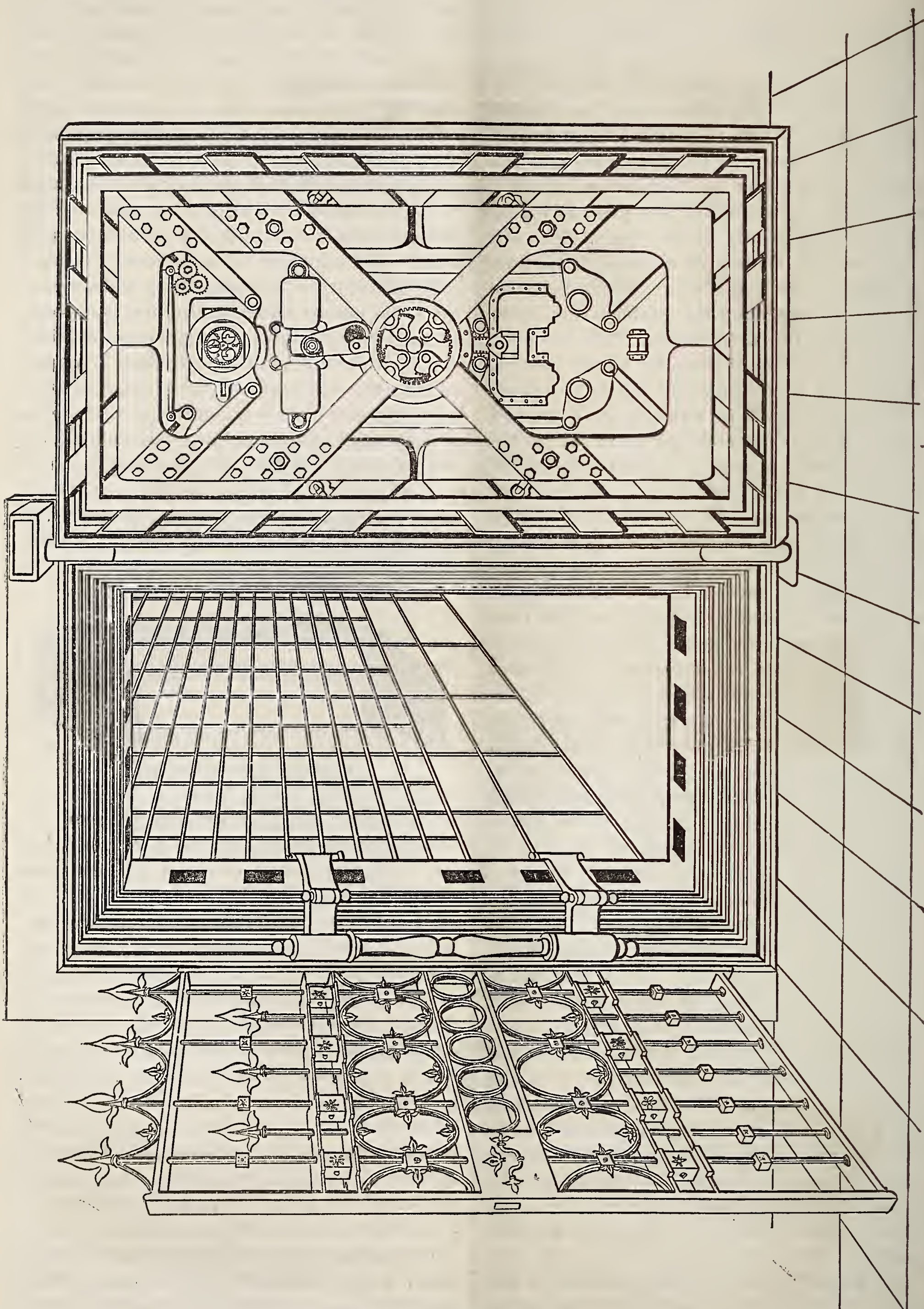
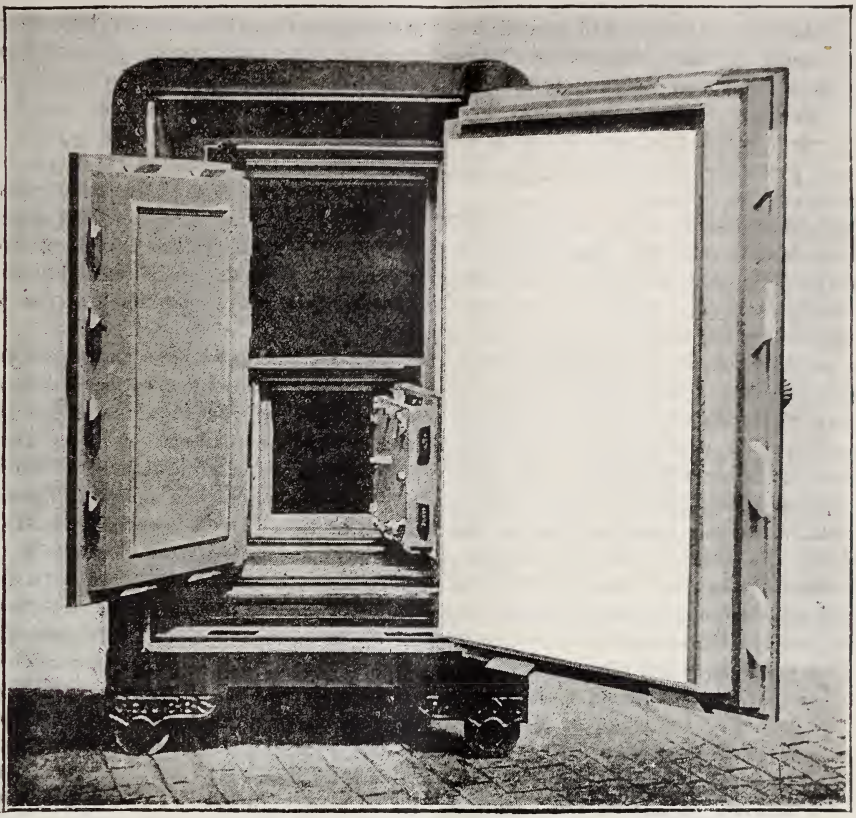


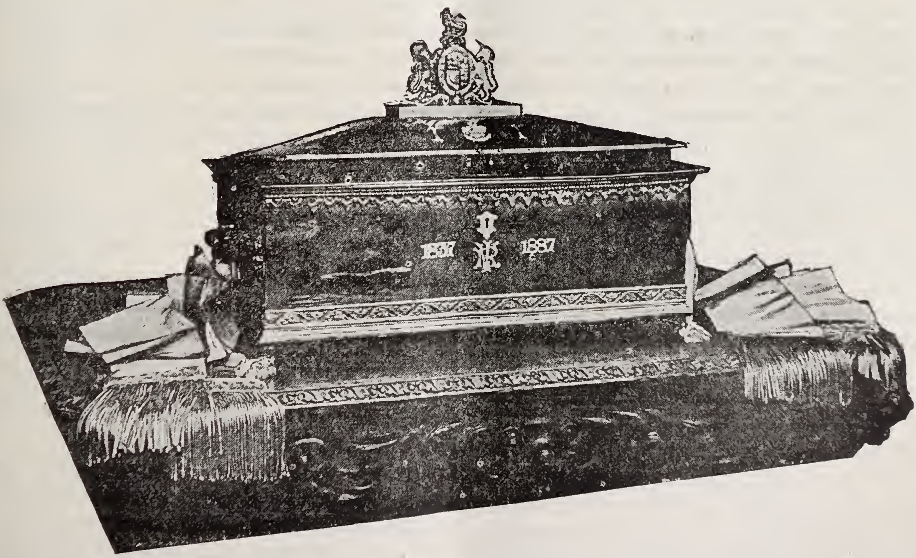
Fig. 10.—Chubb's Safe Deposit.

FIG. 11.



A TRIPLE SAFE.

FIG. 12.



CASKET IN FOUNDATION-STONE, IMPERIAL INSTITUTE.

subsequently hardened. I always dispense with jointing wherever it is possible to bend, or in any other way turn a corner; and these armour plates are as readily and as satisfactorily bent under the round-edge system of safe-making as if they were simply mild steel plates. Movable emery wheels are also applied to cleaning off the heads of composite rivets, and generally producing smooth and level surfaces where necessary.

Fastening the door into its frame has received considerable attention from all English safe-makers, resulting in bolts that claw, clutch, hook, screw, expand, or interlace. Those shown on the diagram of the Chubb door do not shoot forward at right angles to the four sides, but move out at angles of 45 degrees; on each edge some go one way and some the other, thus pointing in opposite directions. By this method they form compound dovetails between the door and its frame, holding the two firmly together in case of attempted wedging. The diagram shows a door of somewhat unusual strength, the bolts being secured, not only by double acting key locks, but also by keyless locks and a "timer."

It is often possible, in the lighter and weaker kinds of safes—safes, I mean, that can be opened with either a pickaxe or a sardine tin opener—to so "make them up" that they may deceive any but experts. This is done by giving the safe an appearance of constructional solidity it does not possess, by showing a thick front all round the door, the door itself seeming to be a plate of solid metal. In reality the appearance is produced by small packing bars, to which, on each side, are fastened sheets of iron no thicker than two folds of brown paper. The joints are filled, or covered with "stopping," and careful painting — sometimes slightly scratched in order to produce an attractive idea of second-handness in the minds of unwary customers—completes the semblance of a safe. It is easy enough to make these as heavy as the real things, by using some weighty material for the fire-resisting (?) filling. What reliance can be placed upon them has been proved in many a fire, for amongst the *débris* of ruined walls one sees them lying about literally in pieces—their contents nowhere.

The safeguard against all this is, of course, to deal only with makers of standing and repute, who will say exactly how the safes of their various qualities are made, the thickness, and material of the plates, &c. Even then it is not an easy task to make a selection, and the puzzled purchaser sometimes seeks professional and independent advice to decide between the rival claimants for his custom. Safe makers are constantly being asked how long their safes will stand a fire, and how long they will resist burglars? To these queries it is almost impossible to give decided and definite answers. The more ready a maker is to give a guarantee that his safe is absolutely fire and thief-proof ,the more cautious should a customer be in accepting the statement. Nothing is perfectly proof against fire and thieves, and the degree of protection obtained largely depends upon the sum of money expended.

Electric burglar-alarms are often used as adjuncts for security in many banks, the system employed being that in which a constant current is maintained, as distinct from the ordinary dwelling-house alarm, where the bell is only rung if the circuit be completed instead of being broken. But it is not sufficient to insure the bell ringing simply if the wires be cut, for burglars with any knowledge of their business will join the wires outside the object protected, so as to leave the electrical circuit still complete. Hence a reliable system should give the alarm even if the wires be joined, as well as cut. The little model I have here, of a strong-room door fitted up with such an alarm, illustrates this. By turning either of the keys, or by breaking either of the wires, or by even joining the wires, the bell at a distance is rung. There is, therefore, a positive advantage in leaving the wires exposed, so as to invite tampering with them. Electricity may also be applied to other objects in connection with strong-room or safe-work, such as locking up gates at a distance, but it must always be borne in mind that wherever a constant current is used the batteries require periodical attention.

Before closing, I should like to refer to the diagrams of some ornamental Chubb master-keys of recent Exhibitions. These are heraldic in character, the proper colours being rendered by translucent or opaque enamels.

On the screen I will presently show a photograph of another piece of modern art-work, viz., the casket now embedded in the foundation-stone of the Imperial Institute, shortly to be opened by her Majesty the Queen.

The many branches of the subject I have brought before you are so voluminous that it has been impossible, in the time at my disposal, to enter fully and perfectly into any one of them. I have simply endeavoured to indicate

the principal steps in their history and development.

How great is the literature of the subject will be seen in the list of books attached, which will I hope serve as a reference to some extent for those who are sufficiently interested to go more thoroughly into it. In compiling this list of books I am largely indebted to the assistance of the Keeper of the Printed Books in the British Museum, Dr. Leitschuh, of Bamberg, and other gentlemen.

APPENDIX.

List of Works and Articles, Relating Partly or Wholly to Locks, Keys, or Safes.

Aitken, W., "Locks," in Beavan's "British Manufacturing Industries." London, 1876, 16mo.; 1877, 8vo.

Androuet du Cerceau. Twenty plates. Paris., fol.

Baudrimont, "Dictionnaire de l'Industrie." Tome x. Paris, 1841, 8vo.

Berthaux, L , "Le Parfait Serrurier." Two parts. Dijon, 1851, 8vo.

Bordeaux, J. H. Raymond, "Serrurerie du Moyen Age." 1858, 4to.

Botterman, J de, "Supplément à l'Art du Serrurerie." Paris, 1781, fol.

Briez, "Notice sur la Serrurerie de Picardie." Abbeville, 1857.

Burty, P., "Chefs d'Oeuvre of the Industrial Arts." London, 1869.

Burty and Thiollet, "Modèles de Serrurerie." Paris, 1826.

Butes, J., "Logistica." Lyons, 1559, 8vo.

Cardeno, G., "De Subtilitate." Nuremberg, 1550, fol.

Carlsruhe Exhibition. "Deutsche Kunst-schmiede und Schlosserarbeiten." Carlsruhe, 1887.

Chubb, G. H., "Protection from Fire and Thieves." London, 1875, 8vo.

Clarkson, D. A., "Ancient Iron Work." London, 1860, fol.

Daly, César, "Motifs divers de Serrurerie." 2 vols., 1881-82, fol.

Deufer, J. et E. Muller, "Album de Serrurerie." Paris, 1872, 4to.

Demont, "Nouveau Traité de Serrurerie." Paris, 1851, 4to.

Denison, E. B. (Lord Grimthorpe), "Clocks and Locks." Edinburgh, 1857, 8vo.

Dictionaries and Encyclopœdias:—"Encyclopœdia Britannica" (9th Edition); London. "Rees's Cyclopœdia;" 1819, London. "Knight's Mechanic Dictionary;" 1878, New York. "Ure's Dictionary of the Arts;" 1875, London. "Zell's Popular Encyclopœdia;" 1871, Philadelphia.

Ferrand, J., "Le Charpentier-Serrurier." Paris, 1881, 4to.

Ferdrin, L., "Nouveau Livre de Serrurerie." Paris, 1723, fol.

Fosbroke, "Encyclopædia of Antiquities." London, 1840, 8vo.

Grivaud de la Vinceille, C. M., "Arts et Metiers des Anciens." Paris, 1819, fol.

Hamel du Monceau, "Description des Arts et Metiers. Art du Serrurier." Paris, 1767, fol.

Hefner-Alteneck, "Serrurerie du Moyen Age;" Paris, 1869, 4to. "Eisenwerke;" Frankfort-on-Main, 1886, 4to.

Hobbs, A. C., "Locks and Safes." London, 1868, 12mo.

Husson, F., "Dictionnaire Pratique du Serrurier." Paris, 1872, 8vo.

———, "La Serrurerie et ses objects d'art . . . Rapports sur l'Exposition Universelle de 1878." 1879, 8vo.

Jousse, M., "La Fidele Ouverture de l'Art du Serrurier." Paris, 1627, fol.

Kabdebo, Stg. v., "Wiener Schmiede (und Schlosser) Werke." Dresden.

Kellen, D van der, "Le Moyen Age." Amsterdam, 1864, 4to.

Kunst-Schmiede-Eisen-Sammlung. Munich, 1881.

Labarte, "Les Arts Industriels du Moyen Age" (vol. ii.). Paris, 1866, 4to.

Lacroix, P. and F. Seré, "Le Moyen Age" (vol. iv.). Paris, 1848-51, 4to.

Lane, "Modern Egyptians," 1849.

Lane-Fox (see Pitt-Rivers).

Lavedom, B., "Guide Pratique de Serrurerie Usuelle." Paris, 1867, 4to.

Liger, F., "La Ferronnerie Ancienne et Moderne." Paris, 1873-75, 8vo.

Mallet and Fairlie, "Safe Challenge Contest." London, 1868, 8vo.

Montfaucon, "L'Antiquité Expliquée" (tome iii.).

Notling, E., "Studie über Altroemische Thür und Kasten-Schlössen." Mannheim, 1870, 8vo.

Paulin-Desormeaux, "Nouveau Manuel du Serrurier." Paris, 1866, 8vo.

Persin, H. de, "Serie de prix pour le reglement normal des travaux de serrurerie et charpentes metalliques, paratonnerres." 1882, 8vo.

Pignorius, L., "De Servis." Patavii, 1694, 4to.

Piot, E., "La Sculpture à l'Exposition" (2nd series, vol. xviii.; "Strozzi," key, p. 825.

Pitt-Rivers, Lieut.-Gen., "On the Development and Distribution of Primitive Locks and Keys." London, 1883, 4to.

Plon, E., "Benvenuto Cellini" (pp. 365-7). Paris, 1883, 4to.

Price, G., "Fire and Thief-proof Depositories." London, 1856, 8vo.

Pugin, "Designs for Iron and Brass-work." London, 1836, 4to.

Ruschdorf, "Abbildungen Deutscher Schmiede (und Schlosser) Arbeiten." Berlin.

Robinson, J. C., "Treasury of Ornamental Art" (plate 70). London, 1857, imp. 8vo. "Catalogue of Soulages Collection." London, 1856, 8vo.
Roussel, P. W., "Histoire et Description du Chateau d'Anet." Paris, 1875, fol.
Sala, G. A., "The Battle of the Safes." London, 1868, 8vo.
Sallengre, A. H. de, "Novus Thesaurus" (Molinus, "De Clavibus Veterum"). Hague, 1716, fol.
Sanguinetti, A., "La Serrurerie . . . au XIX. Siècle." Paris, 1875, 8vo.
Schorn, O. von, "Kunst und Gewerbe." Nurnberg, 1874, 4to.
Silvain, H., "Carnet du Serrurerie-constructeur." 1879, 12mo.
South Kensington Museum, 50 Etchings of Objects of Art (series 1-5). London, 1867-70, fol.
Tomlinson, C., "Rudimentary Treatise on Locks." London, 1853, 12mo. "Encyclopœdia of Useful Arts" (vol ii.). London, 1866, 8vo.
Tomlinson and Mallet, "Locks and Safes." London, 1868, 12mo.
Walther, Professor C., "Die Kunstschlosserei." Stuttgart.
Wasmuth, "Die Schmiedekunst." Berlin.
Weise, "Dresdener alto Schmiedenwerke." Dresden.
Wilkinson, "Manners and Customs of the Ancient Egyptians." London, 1878.
Wyatt, M. Digby, "Specimens of Ornamental Art Workmanship." London, 1852, fol. "Observations on Metallic Art." London, 1857, 4to.

Papers.

Chatwood, S., "Locks and Safes." *Journal of the Society of Arts*, 1888.
Chubb, J., "On the Construction of Locks and Keys." Institute of Civil Engineers, 1850.
Chubb, J., "On the History and Construction of Latches and Locks." Society of Arts, 1851.
Cumming, H. Syer, "History of Keys." Archæological Association, 1856.
Higgin, "A Sketch of the History of Ancient Door Fastenings." Lancashire and Cheshire Historical Society, 1850.
Tonks, "Gold and Silver Keys." Birmingham Architectural Association, 1888.

Articles.

"American Historical Record," vol. ii., p. 122.
"Art Journal," vol. ix., p. 85; also vols. for 1852, pp. 218, 250, 305.
"Bankers' Magazine," vol. ii., pp. 572, 632.
"Cassell's Magazine of Art," vol. ii., p. 75; and vol. iii., pp. 16, 174.
"Chambers's Journal," vol. xviii., p. 405; vol. xlviii., p. 107; vol. lii., p. 648.
"Cornhill Magazine," vol. xii., p. 623.
"Cosmopolitan," October, 1891.
"Good Words," vol. xx., p. 85.
"Journal of Franklin Institute," Philadelphia, vol. lxviii., p. 66; and vol. lxxv., p. 202.
"Saturday Magazine," April, 1839.
"Journals" of the Archæological Institute and Association.

DISCUSSION.

Mr. S. S. BROMHEAD asked whether Mr. Chubb had considered the question of utilising aluminium in the manufacture of keys, as, when people had a number of keys to carry, the question of weight was of considerable importance. Any metal which would not oxidise must, to a great extent, preserve a lock from becoming hard in its movements. Personally, he felt very much obliged to Mr. Chubb for his admirable paper, and the many beautiful illustrations which adorned the walls of the room. If possible, he hoped that something approaching the American key of the Yale latch could be introduced into this country, as one of their great advantages was the small space they occupied in the pocket. He should be glad to know whether there was any practical objection to adopting a flat key, because, if not, and it could be made of aluminium, it would be very light.

Mr. R. L. COLE said that, as an architect, he was very much interested in the construction of strong-rooms, and regretted that no details had been given with regard to the construction of floors and ceilings. Everyone knew that strong rooms were subject to attack by burrowing; many successful attempts had been carried out in this manner and, therefore, he should like to know what was the most generally adopted system in America for floors and ceilings. He noticed in one of the illustrations thrown on the screen that the joints appeared to be riveted on the outside, but in his opinion the best plan was to make the joints so that they were not externally visible. Of course, the circumstances under which the safe had to be fixed had in all cases to be considered. With regard to time locks, he rather gathered from the remarks of Mr. Chubb that his opinion was that these were really the locks of the day.

Mr. H. B. WHEATLEY said one point which must have struck every one was the artistic beauty of the old keys shown by Mr. Chubb, thus illustrating what we know from other sources, that locksmiths in olden times were artificers who were held in the highest esteem. There was one safe of great interest which had not been referred to, viz., the chest which held the Domesday Book in the Record-office. This chest had three locks, which were broken open in the time of Edward I., when the treasury at Westminster was robbed. Another matter with regard to the robbery from safes worth noting was the robbery of the king's treasure in the reign of Edward the Confessor. In Mr. Hubert Hall's interesting book on the "Antiquities of the Exchequer," there was an account

of the robbery of the chest which stood in the bedroom of the king. In early times the treasury of the king was usually kept in his bed-chamber, and on one occasion the Chamberlain had left the door of the chest open while he went to pay some of the servitors of the Palace. In his absence the kitchen scullion came in, and thinking the king was asleep, took out some of the money. The king happened to be awake, and he, thinking the Chamberlain would soon be back, called out to the man to fly quickly in case the Chamberlain should return, in which case he would not leave him a halfpenny to take away. This showed a sense of humour in Edward the Confessor, which reminded him of the well-known story of Charles II. and the pickpocket.

Mr. CHUBB said that he had made keys of aluminium, but found they had no wearing property. If the noses of the steps of the key were not very hard they would not wear for any considerable time. With regard to the desirability of a flat key, he might say they could be made for the ordinary Chubb lock. People had the impression that flat keys were more readily copied, and, to a certain extent, this might be true. The degree of accuracy required in a good lever lock was of a very fine degree. It would be more easy to copy a flat key than one with a pin or pipe to it. He tested the degree of accuracy some time ago, and found that in a little three-inch lock the difference of 1-200th part of an inch in the length of one of the steps of the key was just sufficient to prevent a wrong key from acting. This test was made by means of a micrometer, which gauged to the 1-10000th of an inch. With regard to the details of floors and ceilings of strong-rooms, he had not endeavoured to touch on architectural features, but he considered the best thing was to have no floor at all; in other words, to have a cellar under the strong-room which could be occasionally inspected. If there was a cellar, the burglar would have first to burrow into this before getting to the strong-room. With regard to the ceiling, he preferred to have it arched, as in the event of a fire (which was the chief thing to be considered), any beam or joist, or large piece of metal-work, which became detached and tumbled down, would have its fall considerably broken. No doubt in the illustrations thrown on the screen the joints in the plates of the strong-rooms had external flitch bars, but it was just as easy to make them internally, and this was often so done. A perfectly smooth and flush surface presented more difficulties to the burglar than anything which had projections on it. With regard to time-locks, he had endeavoured as far as possible not to express any opinion, but merely to state facts. There was no doubt they were being used more and more, and it was simply a question of time as to how soon they would become general in this country.

The CHAIRMAN said he was sure everyone would appreciate the labour which Mr. Chubb had been good enough to undertake in the preparation of so interesting a paper. He had commenced with the Egyptians, gone on to Chinese and Japanese, and eventually brought them down to the most modern and scientific time-locks, and under these circumstances he had much pleasure in asking the meeting to record a cordial vote of thanks to Mr. Chubb.

The vote having been unanimously passed, the meeting adjourned.

Mr. SAMUEL CHATWOOD writes:—The shortness of the time available after the reading of Mr. Harry Chubb's interesting paper on ancient locks precluded the possibility of discussion of practical matters in connection with the safe and lock controversy. I was personally disappointed that Mr. Harry Chubb only devoted a very few minutes to modern locks, and hardly touched English security arrangements at all, but rather magnified American practice, particularly in the matter of safe deposit work and time-locks. Of course, in one paper it would be impossible to cover the ground, and Mr. Harry Chubb selected ancient locks as the base of his very interesting paper. I was surprised to hear him, at the close of the discussion, ascribe the time-lock to the Americans, as it is distinctly an English invention, the patent for which was offered to me at my Manchester office some 35 years ago. I believe the inventor was a Salford man. I declined to purchase it, as I found the attempt to raise the standard sufficiently great in those days without attempting the introduction of the time-lock. The time-lock was no good on safes which the burglar could force, and before the Cornhill burglary our bankers even would not pay for good safes, and when, in 1865, I wrote a letter to the *Times*, that a really burglar-proof safe must be made of intersected steel two inches thick, a quality which our bankers and jewel merchants were not willing to pay for, the late Mr. Milner retired to his room and wept, asserting that my impossible standard would ruin the trade; but now that this standard has been accepted, the time-lock is of value for the protection of the holders of the keys, as these can only be used after the time for which the time-lock has been set before the locking up of the safe or strong-room. The time-lock found its place in America, where the keys or the lock combination could only be held by a bank officer at the risk of his life, until they were made of no avail except in business houses, and the instrument has been developed and perfected to a high degree; but the invention was submitted to me in practicable form by the patentee, as I state, about thirty-five years ago. Touching the American safe deposit work, it should be stated that the proprietors of these safe deposits in America are wealthy corporations, who do not hesitate to expend upon them some £50,000; whereas, in England, it is usual to form a small limited liability company, with just enough capital to pay for the safes and strong-rooms, often in hired buildings, but with no capital

to fall back upon in the event of accident or of the fraud of their servants. The renter in these safe deposits is at the mercy of the officers of these small safe deposit companies, as the compartment, of which he holds one key, is in no sense a safe, but only a lock-up of a flimsy description, apart from the strong-room, the keys of which are controlled by the servants of the safe deposit companies; whereas, the renter should be able to feel that the key in his own possession should secure him absolutely against the possibility of his safe being broken open, apart from the strong-room in which it is placed. Touching the question of the metal poured between plates, I remark that it does not owe its hardness to chilling action at all, as before we can pour it between the two steel bodies of our intersected steel safes, we are obliged to expand them by heat, otherwise the unequal contraction would so distort and twist them as to render the system impracticable. The excessive carbon renders the speigel forming the intersecting cones and intermediate plate so hard, that it will cut glass like a diamond, without any chilling action, which it will be seen is impossible of application in this system of manufacture. As to fire-proofing in America, I was amused to watch the filling of the safes, and observed that the inner and outer shells were stayed and propped, whilst the cement was poured in and set, and satisfied myself that it was really the stone wall thus formed which constituted the strength of the ordinary American safe. On the question of suitable steel for defeating the burglar's drill, of course it will be evident that steel with ·6 carbon will not offer much resistance to the burglar's drill, though it will increase somewhat the cost of workshop manipulation. The true principle for defeating the burglar's drill is, after all, a combination of hard and soft metals; the soft to protect the hard from fracture by concussion, and the hard to protect the soft from being cut away; and to this particular branch of the subject I have devoted much attention for the past 33 years, my first patent having been taken out in 1860. I followed this up by introducing solid plates of steel, with high carbon centres and soft exteriors; and, in 1885, I invented, as a cheap substitute for our patent hard centre compound steel, the system of hard-strand steel, *i.e.*, plates of soft steel, with strands of high-carbon steel formed by placing high-carbon steel bars in the ingot moulds, heating them *in situ*, then filling up with ingot iron or low-carbon steel. I communicated this invention to the New British Iron Company, at their Corngreave Works, Birmingham, in 1885, but I have not found the plates made under this latter plan drill-proof, but good against the cutting of large holes in the doors of safes or sides of strong-rooms, which was, indeed, the object I had in view in making the invention. I have been led to make this note somewhat longer than I should have made my remarks, had time permitted in the discussion, but I trust you will be able to find room for them.

Miscellaneous.

THE PRODUCTION AND USES OF PLATINUM.

Since the introduction of the incandescent electric lamp in 1880, the consumption of platinum, not only in the United States but in Europe also, has increased rapidly, although improvements made from time to time have greatly reduced the amount used in each lamp. The New York *Engineering Journal* says that the gross amount of platinum used in the United States and in Europe in the manfacture of electric lamps has steadily increased from almost nothing in 1880, to about 55,000 ounces in 1892. There are at present two other uses for platinum, which are even more important than its use in electric lighting, namely, the construction of stills for the concentration of sulphuric acid, and the wires by which artificial teeth are firmly fastened to a plate The amount used for stills varies widely from year to year, being greatly dependent upon the number of new plants started each year, but it has been estimated that the average amount so used during the last few years is about 80,000 ounces. The manufacture of sulphuric acid is sure to increase, and, although glass concentrating vessels are now used to some extent, it is believed that this industry will continue to supply a constantly increasing demand for platinum. For dental purposes platinum will always continue to be used, being the only metal which possesses the required properties of infusibility, ductility, and strength. In the United States 35,000 ounces, and in the United Kingdom 25,000 ounces, are annually used in this industry, and this amount will, it is said, probably increase at the rate of 2 or 3 per cent. per annum. The other uses of platinum, such as chemists' crucibles, jewellery, plating, &c., consume about 20,000 ounces annually, making the entire consumption about 215,000 ounces. Of this amount about 30 or 40 per cent. is old or scrap platinum. For many years the Siberean Urals have supplied the greater part (92 per cent.) of all the platinum used in the world, but it is questionable whether its output can be maintained at its present high level for many years. According to the official statistics of the Russian Department of Mines, the output of platinum in that country reached its maximum in 1887, 4,400 kilogrammes. It dropped afterwards to 2,700 kilogrammes, and so remained until 1891, when, owing to the abnormally high price of the metal, the production amounted to 4,226 kilos. It is believed that the above figures represent the maximum output of the country. Next to Russia the most important sources of platinum so far known are Colombia, British Columbia, and the United States. At present Colombia only produces about 125 kilogrammes of platinum per annum, entirely the result of native

washing. The platiniferous area, although of low grade, is, however, very extensive, and in part suitable for hydraulic mining. A large quantity of American capital has already, it is said, been invested there, and it is expected that Colombia will become an important producer of the metal. The only platinum deposits of importance in British Columbia are found on the Talameen River. The total production in British Columbia is about 65 kilogrammes. In the United States much prospecting has been done to find platinum in paying quantities, but so far without success, and to the present time all the platinum produced has been incidental to the production of gold from various auriferous gravels in California and Oregon.

CARVED FRUIT STONES.

Nothing is wasted in China. The stones of various fruits and the shells of nuts are cleaned, dried, and carved into ornaments of the most graceful kind. Among the stones used are the olive, plum, peach, and cherry, and of the shells the walnut and cocoa-nut. The stones are collected with care; each must exceed a certain standard of size, proportion, hardness, and weight. They are dried slowly and at such a heat as not to crack or sprout, and are then ready for the carver. The designer makes a rough outline of the future group or picture, and hands it over to his boys or apprentices. These work with great rapidity and soon block out the design, cutting through the hard ligneous tissue, and then extract the kernel. A second treatment now takes place to dry the interior of the stone, as well as to prevent the fine lining of the interior from undergoing decomposition. This completed, the designer sketches a second outline, and also indicates by his pencil or brush where the surface is to be manipulated, made into leaf-work or arabesque, or be cut altogether away. The work is performed by the subordinates, as at first. The designer then does the finishing touches, after which the assistants clean, polish, and oil or wax the perfected carving. The stones are sold in this shape to quite a large extent, but more largely in other forms. Among these may be mentioned buttons, watch charms, sleevelinks, earrings, and brooches, and, when strung together, bracelets, anklets, necklaces, watch-chains, rosaries, and official ornaments. The price of a stone varies greatly with the workmanship and the fame of the carver. Some may be bought as low as 5d. a piece, others command as high as 8s. and 12s. each. The average price is 1s. 3d. a stone, with a handsome discount for purchases in quantity. The carvings display great variety and beauty. One class represents bunches of flowers and leaves, in which pistils, stamens, and tendrils are accurately executed. Similar to these are fruits and flowers, and flowers and leaves. A second class is composed of carvings of birds, reptiles, and higher animals. The dragon, griffin, stork, horse, lion, tiger, camel, elephant, and bull are the favourite figures. A canon in Chinese carving is to reproduce only those animals which have been deified, and those mentioned are about the only ones which have enjoyed divine honours. A third class, and by far the most interesting, comprises groups of human figures representing scenes in history, poetry, mythology, and the drama. The workmanship is often so fine as to be microscopic in its delicacy. In fact the finishing touches are made by the artist while using a magnifying glass of at least fifty diameters. On stones not over an inch in length along their major axis, it is not uncommon to find eight, nine, and ten characters in different attitudes and costumes. Unlike most phases of Chinese art, there is much regard paid to perspective and foreshortening. Some of these pieces might have been made by Hindoo or Italian artists, so free are they from local conventionalism. Nevertheless, in the main, conventionalism is all-prevailing.

Correspondence.

MANUFACTURE OF WHITE-LEAD.

In the paper on "Non-poisonous White-lead," read before the Society of Arts by Mr. Nursey on the 22nd ult., an account is given of the various processes in the manufacture of white-lead, and as the inventor of one of those described, I could have wished the chemistry of the subject had been entered upon. Did space permit I should be pleased to have shown that the Thenard and earlier precipitation processes failed, because the conditions involved the production of a neutral carbonate. Stack white-lead is made under conditions which involve a basic carbonate, and it can be shown that the stacks under adverse conditions could be made to produce a neutral carbonate no better than Thenard's, while by reasoning inversely it can be seen that precipitation can produce a basic carbonate, equal both chemically and physically to stack-made white-lead. In fact, a well-known brand of white-lead, which has borne a high reputation in the market for years, and is generally supposed to be stack-lead, is made by a quick process of precipitation. The stack process uses metallic lead, so does the process last referred to, so did the Martin process, when it was in the hands of the inventor. This process is of 14 years' standing, but as litharge was some time since substituted for metallic lead, the works have been recently closed. Thenard, Gossage, and other earlier inventors, used litharge, and it is suggested in processes of the present day, but although white-lead is speedily made from it, it involves difficulties metallic lead is

free from, and there appears to be no process using litharge now in operation. It may be said that the true way to success in new processes is to observe closely the reactions and conditions of the stacks, as any violation of these invariably leads to failure. The sulphate of lead, as described in the paper read, appears to be neutral sulphate, and is, therefore, as a pigment, much in the condition of Thenard's neutral carbonate, and some considerable change will have to be effected before it can take rank with basic carbonate, the ordinary white-lead.

J C. MARTIN.

London, April 4th.

OCCUPATION AND CASTE IN INDIA.

With reference to Mr. Baines's reply to the discussion on his paper "Occupation and Caste in India as shown in the last Census," printed in the *Journal* of March 31st, Dr. G. W. Leitner writes :—

"I explained the Arabic term of 'Zu'l-Qarnein,' or the 'possessor of two horns,' as applied to Alexander the Great, and I can only add that—whether successful with Jupiter Ammon or not—he is represented on coins, of which the Arabs knew, with two horns. The term would also be applicable to his rule over 'the East and West,' over 'two continents,' if not two hemispheres, and it further is the form of a crescent. I am not the author of the myth that the Hunza dynasty is descended from Alexander, but the innocent cause of drawing attention to that great conqueror in a country at a time when even his name was previously unknown in it. As for Alexander's invasion having exercised an influence on the art and civilisation generally of Upper India—which Mr. Baines denies—I can only refer to Plutarch's Orations on the subject as also to other allusions in Greek and Latin authors regarding that great influence which I mention in the current number of the *Asiatic Quarterly Review*."

Regarding the linguistic identification of the Dôms of the Upper Indus, or "Sinn," with the "Rôms" or "Romanî" of Europe, Dr. Leitner points out that it is based on a comparison of their dialects, with which he is acquainted. The deviation of "Zingari" from "Sinkari," or inhabitants of the banks of the river "Sinn," is not "one out of a hundred, if not more," but is a suggestion based on researches made by him among the gipsies of Europe and Asia, and not on conjectures. He adds :—"The assertion that 'the gipsies came to Europe as musicians' is too sweeping, though it supports their identification with my Dôms, who are hereditary musicians and tinkers. I would here refer to my treatise on the 'Changars' and the wandering and criminal tribes that periodically visit India from Central Asia, which are published as a 'Selection from the Records of the Punjab Government.'"

Obituary.

MR. VICAT COLE, R.A.—This distinguished landscape painter, who died on the 6th inst., had been a member of the Society of Arts since 1880, and in 1885 he become a member of the Council of the Society. The son of a painter of some success, Mr. George Cole, he was born at Portsmouth in 1833, and early came into public notice. When nineteen, he made his first appearance in the metropolis by exhibiting, in the galleries of the Society of British Artists, two canvases representing the picturesque scenery of the Wye. A few years later the Fine Arts Society conferred upon the rising young artist its silver medal for his "Surrey Cornfield," which was afterwards seen at the International Exhibition of 1862. One of the most admired of his more recent works is "The Pool of London," painted about five years ago, and purchased for the Chantrey Bequest. His "Houses of Parliament," finished as recently as last spring, is also well known. In 1870 he was elected an Associate of the Academy, and, in 1880, a Royal Academician.

General Notes.

COLLECTION OF PHOTOGRAPHS.—A collection of photographs of members of the Society of Arts, taken by Messrs. Maull and Fox, of 187A, Piccadilly, has been received from that firm.

EXHIBITION OF INDIAN WOMEN'S EMBROIDERY AND NEEDLEWORK.—The Committee of the Society for the Encouragement and Preservation of Indian Art have decided to organise an Exhibition of Indian Women's Embroidery and Needlework to be held in the Imperial Institute on May 10th. It is intended that a descriptive catalogue of the exhibits shall be printed, and the committee will be glad to receive as early as possible, information as to specimens suitable for exhibition which may be in the possession of members or their friends, so that each may be adequately described in the catalogue. The Honorary Secretary is Mrs. David Carmichael, 16, Grenville-place, S.W.

THE SALT MINES OF COLOMBIA.—Salt mines are met with in Colombia exactly thirty miles to the north of Bogotá, at a village named Zipaguira on the plains of Bogotá, the tunnels running into the mountains at an elevation of about 500 feet immediately at the back of the village. The British Vice-Consul at Bogotá states that the main mountain appears to be one mass of rock salt. This is blasted out by means of powder and sold by the weight. The salt water is also collected and evaporated in open tanks producing a fine white powdery

salt. Pre-historic legends allege, and the geographical formation of the country would appear to bear out the assertion, that the plains of Bogotá were originally one vast lake stretching north and south, about 150 miles, but that the waters found an outlet at the south end of the present plains at a place called Tequendama, where exists now one of the most beautiful waterfalls in the world. The salt mines at Zipaguira were known to and used by the Indian, long before the Spanish conquest. The mines are a Government monopoly and a source of great revenue, and on the breaking out of a revolution Zipaguira is a main place of attack and defence. At the present moment the mines are not fully worked, one main tunnel and shaft being closed up, yet the mines supply nearly the whole of Colombia with salt.

The Press at the Chicago Exhibition.—Major M. P. Handy, Chief of the Publicity and Promotion Department, furnishes the following particulars:—"Newspaper head-quarters will be in the Administration Building, at the very nerve centre of the Exposition. Three floors of the north-west pavilion have been reserved for this purpose. One for the department offices, one for the local press, and one for press associations, foreign newspapers, and file rooms. It will be impossible to give separate rooms even to the leading newspapers of the country, but desk room will be abundant, type-writing machines will be at hand, and there will be separate rooms for those great newspapers of Chicago and other cities which have regular staffs on duty throughout the period of the Exposition. In regard to the extension of courtesies to newspaper men, the department has recommended that a most liberal policy be adopted. This contemplates the issue of three kinds of tickets of free admission on account of the Press; first a complimentary engraved invitation for journalists of distinction, and the editors of the great newspapers of the world; second, season or term tickets for men who come here to work; and third, single admission for transient visitors. It is as much to the interest of the Press as of the Exposition that these privileges shall not be abused, and care therefore will be taken not to extend such courtesies to any persons not fully accredited and identified. Applications are now coming in in great quantities by every mail, and it is no small work to classify and arrange them, and decide upon the merits of each individual application."

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock:—

April 19.—Gisbert Kapp, "Some Economic Points in connection with Electricity Supply."

April 26.—H. Van der Weyde, "The Optical Correction of Photographic Perspective."

May 3.—

May 10.—

May 17.—F. E. Ives, "Composite Heliochromy."

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

April 27.—Sir Juland Danvers, K.C.S.I., "Indian Manufactures: their Present State and Prospects." Sir Alexander Wilson, formerly President of the Bengal Chamber of Commerce, will preside.

May 18.—Sir Raymond West, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results." The Right Hon. Sir James Fergusson, Bart., G.C.S.I., K.C.M.G., C.I.E., M.P., will preside.

Foreign and Colonial Section.

Tuesday evening at Eight o'clock:—

April 18.—H. A. McPherson, "The Philippine Islands." Charles Malcolm Kennedy, C.B., will preside.

May 2.—E. Delmar Morgan, "Russian Industrial Art."

May 16.—W. B. Perceval, Agent-General for New Zealand, "New Zealand."

Applied Art Section.

Tuesday evenings, at Eight o'clock:—

May 9.—Prof. W. M. Flinders Petrie, "Primitive Art in Egypt." Edward J. Poynter, R.A., will preside.

May 30.—James Dallas, "Devonshire Pottery." C. M. Kennedy, C.B., will preside.

Cantor Lectures.

Monday evenings, at Eight o'clock:—

Lewis Foreman Day, "Some Masters of Ornament." Four Lectures.

Lecture II.—April 17.—The spreading of the Renaissance—Its introduction into France under François Ier and the Valois, and its rise in Germany—With illustrations of the works of Primaticcio, Jean Cousin, A. du Cerceau, P. Wœriot, Jean de Pol, F. Siebecq, Orance Finé, Paul van Schelden, Martin Schöngauer, Israhel van Meckenen, Peter Vischer, George Syrlin, A. Dürer, H. S. Beham, Lucas van Leyden, D. Hopfer, Hans Holbein, Hans Mielich, Aldegrever, and others.

Lecture III.—April 24.—The latter Renaissance—The Netherlands—Louis XIII. and the beginning of the Baroque—With illustrations of the works of Virgil Solis, Floetner, G. Tory, Le Petit Bernard, Hurtu, Fontin, La Quevellerie, Jost Amman, G. Wechter, B. Zan, P. Flynt, W. Dietterlin, G. Bang, A. Collaert, J. V. de Vries, H. Janssen, S. Vouet, and others.

Lecture IV.—May 1.—The French styles—Louis XIV., Louis XV. and the Rococo—Louis XVI. and the revival of Classicism, and the Empire—With illustrations of the works of Le Pautre, Le Brun, Jean Vauquer, Jean Berain, D. Marot, A. C. Boulle, Claude Gillot, Watteau, G. M. Oppenort, F. de Cuvilliés, J. A. Meissonier, Cauvet, Gouthière, C. P. Marillier, La Londe, Salembier, Passarini, and others.

C. Harrison Townsend, F.R.I.B.A., "The History and Practice of Mosaics." Two Lectures.

May 8, 15.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 17 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis F. Day, "Some Masters of Ornament." (Lecture II.)

British Architects, 9, Conduit-street, W., 8 p.m. Mr. H. W. Burrows, "Examination of Building Stones."

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Major Conder, "Comparison of Asiatic Languages."

[Tu]esday, April 18...SOCIETY OF ARTS, John-street. Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. H. A. McPherson, "The Philippine Islands."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. J. Macdonnell, "Symbolism, in Ceremonies, Customs, and Art."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on paper by the late Mr. P. W. Willans, "Steam-Engine Trials."

Statistical, School of Mines, Jermyn-street, S.W, 7¾ p.m. Mr. Augustus Sauerbeck, "Prices of Commodities during the Last Seven Years."

Pathological, 20, Hanover-square, W., 8½ p.m.

North-East Coast Institute of Engineers and Shipbuilders, Durham College of Science, Newcastle-on-Tyne, 8 p.m. Discussion on Mr. S. O. Kendall's paper "Strains of Tank Steamers."

Zoological, 3, Hanover-square, W., 8½ p.m. Mr. Arthur E. Shipley, "Notes on the Genus *Sipunculus*."

Wednesday, April 19...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Gisbert Kapp, "Some Economic Points in connection with Electricity Supply."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. F. Campbell Bayard, "The Direction of the Wind over the British Isles, 1876-80." 2. Mr. H. C. Russell, "Notes on Photographs of Lightning taken at Sydney Observatory, December 7th, 1892." 3. Dr. Ernest H. Cook, "Notes on Lightning Discharges in the neighbourhood of Bristol, 1892." 4. Mr. W. W. Midgley, "Constructive Errors in some Hygrometers."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Prof. D'Arcy Thompson, "A new Tapeworm, *Tæniaechidna*." 2. Mr. F. Chapman, "The Foraminifera of the Gault of Folkestone."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

Thursday, April 20...Royal, Burlington-house, W. 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Chas. Chilton, "The Subterranean Crustacea of New Zealand, with some General Remarks on the Fauna of Caves and Wells." 2. Mr. H. M. Bernard, "Notes on the Anatomy, Physiology, and Histology of the *Chernetidæ*, with special reference to the Rudimentary Stigmata, and to a new form of Trachea."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. Horace T. Brown and Dr. G. Harris Morris, "A Contribution to the Chemistry and Physiology of Foliage Leaves." 2. Messrs. C. F. Cross, E. J. Bevan, and C. Beadle, "The Interaction of Alkali Celulose and Carbon Bisulphide—Celulose Thio-Carbonates;" and other papers.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Atmosphere."

Historical, 20, Hanover-square, W., 8½ p.m. 1. "The Statutes of the Company of Mercers of Lichfield in the 17th Century," communicated by W. H. Russell, with an Introduction by the Rev. Prof. W. Cunningham. 2. Hubert Hall, "The Anglo-Russian Convention of 22nd June, 1799, and the Campaign of the Second Coalition."

Mechanical Engineers, 25, Great George-street, 7½ p.m. 1. Prof. W. C. Roberts-Austen, "Second Report to the Alloys Research Committee." 2. Mr. William Dean, "Tensile Tests and Chemical Analyses of Copper Plates from Fire-boxes of Locomotives on the Great Western Railway." 3. Prof. T. Hudson Beare, "Research Committee on Marine-Engine Trials: Abstracts of results of Experiments on Six Steamers, and Conclusions drawn therefrom in regard to the efficiency of Marine Boilers and Engines."

Numismatic, 22, Albemarle-street, W., 7 p.m.

East India Association, Westminster Chambers, 3, Victoria-street, S.W., 2½ p.m. Brigade-Surgeon R. Pringle, "Indian Hemp" (Ganja), from a public health point of view.

Friday, April 21...United Service Institute, Whitehall-yard, 3 p.m. Major-General F. H. Tyrrell, "Universal Compulsory Service for the United Kingdom."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. A. B. W. Kennedy, "Possible and Impossible Economies in the Utilisation of Energy."

Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Papers and discussions continued.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, April 22...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. James Swinburne (Tyndale Lectures), "Some Applications of Electricity to Chemistry."

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,109. Vol. XLI.

FRIDAY, APRIL 21, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the Imperial Institute, South Kensington (by permission of the Executive Council), on Wednesday, June 21.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member.

Further particulars as to the arrangements will be announced in future numbers of the *Journal*.

CANTOR LECTURES.

The second of the course of lectures by Lewis Foreman Day, on "Some Masters of Ornament," was delivered on Monday evening, April 17.

The lectures will be printed in the *Journal* during the summer recess.

FOREIGN AND COLONIAL SECTION.

On Tuesday evening, April 18, H. A. McPherson read a paper on "The Philippine Islands." Charles Malcolm Kennedy, C.B., Member of the Council, presided.

The paper and discussion will be printed in the next number of the *Journal*.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d., on application to the Secretary.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Monday, April 17. Present:—Sir Frederick Bramwell, Bart., D.C.L., F.R.S., in the chair; Sir Frederick Abel, K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Birkbeck, Bart., Sir Edward Braddon, K.C.M.G., Michael Carteighe, Sir George Hayter Chubb, Francis Cobb, Sir Henry Doulton, Francis Elgar, LL.D., Charles Malcolm Kennedy, C.B., Sir Villiers Lister, K.C.M.G., John Biddulph Martin, John Fletcher Moulton, Q.C., F.R.S., John O'Connor, William Henry Preece, F.R.S., Sir Robert Rawlinson, K.C.B., and Sir Saul Samuel, K.C.B., C.B.

PASSENGER RATES TO AMERICA.

The Hamburg-American Packet Company offer to convey members of the Society of Arts to New York at a rate of £14, single fare, first-class, on the understanding that at least fifty members travel by this line during July and August. The company's steamers sail from Southampton every Friday.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, April 11, 1893; Thomas Wardle in the chair.

The Chairman said that he had much pleasure in introducing to the meeting his friend Professor Schulze, whose acquirements in the field of weaving-history had won for him deserved European acknowledgment. For the whole of his art-life, as lecturer on textile art, and as Conservator of the magnificent Textile Museum at the Royal Silk Weaving School, at Crefeld, near Cologne, he had devoted himself with great assiduity to the collection of patterned fabrics, chiefly but not entirely of silk, of all countries and of all ages. Judging from the very extensive collection, and the scientific and splendid chronological and geographical arrangement of the textiles in this Crefeld Museum, the most complete, with perhaps the exception of the one in Berlin, of any in Europe he knew of, there was

no authority better qualified to speak to them that night on a subject of such general interest as the history of pattern designing.

The paper read was—

HISTORY AND DEVELOPMENT OF PATTERN DESIGNING IN TEXTILES.

By Paul Schulze,

Conservator of the Royal Textile Collection, and Lecturer on Art in the Royal Weaving School at Crefeld.

A German proverb says, "Kleider machen Leute," which is equivalent to the English "Fine feathers make fine birds." Another proverb runs, "We receive a man according to his dress, and dismiss him according to his intellect." Accordingly, we find that it is a first principle in human nature to take special care as regards the attiring of the body. Savages only make a modest attempt by tattooing their bodies, while the civilised nations of all ages and countries have made an art of dressing themselves in splendid and rich costumes. This endeavour gave birth to an industry which, up to our days, has contributed in no slight degree to the prosperity of many towns and countries—I mean the textile industry.

It is not my purpose to read a paper upon the history and development of art and industry. My particular object is to give a very general summary of the evolution of textile design from the earliest times, and to show how many interesting details can be supplied by such an apparently insignificant subject as that of woven designs.

With regard to the period at which our investigations should commence, it might be considered that the art of usefully applying such perishable materials as the fragments of flax, the wool of sheep, and the fine threads spun by the silkworm, dates from no very distant time. But that is a great mistake.

We should be wrong in placing the birth of the textile industry at the commencement of the Christian era. We should be equally in error if we placed this period 1,000 years further back, to the time when Greek art was not yet spoken of, much less European culture. We can, with confidence, go back 3,000 years, that is, in all 6,000 years from the present time. Monuments of the early period prove to us that, even then, there was a culture in ancient Egypt, which did not exclude the existence of a textile industry; on the contrary, its existence may be proved almost with certainty.

King Menes is said to have reigned over Egypt about the year 4000 B.C. He was accused by his successor of having enervated his people by excessive luxury. He was cursed by the priests (who also may be taken as a token of civilisation), and this curse was engraved upon a square stone. The author Ebers

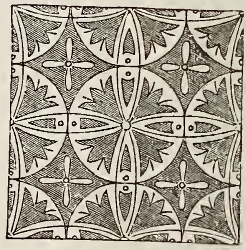


Fig. 1. Combination of Lotus Flowers.

informs us how an Egyptian King's mother occupied herself with the study of physic, and concocted a lotion to make the hair grow. Now, I think I may fairly conclude that a race of people, who were in need of some means to make the hair grow more freely than in its natural condition, would not have neglected the protection and adornment of the other parts of the body; hence the existence of textile industry may be easily in-

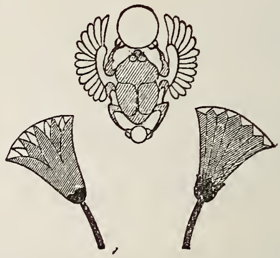


Fig. 2. Flowers of the Lotus and Papyrus Plants.

ferred. No remains of stuffs from this period are extant, but the paintings in the Pyramid show the Egyptians dressed in gowns striped with primary colours, blue, red, and yellow. Besides this, little designs have been found which are evidently reproductions of woven patterns. There are little drawings of geometrical construction, combinations of lotus flowers (Fig. 1), &c. There are also other motives in the designs from which we may

conclude that they were applied to clerical vestures.

In a series of centuries we find that forms of certain animals, plants, &c., which were deemed sacred to religious service, were used symbolically for the designs for clerical vestments and antipendiums. Hence, it is probable that the Egyptians likewise used the forms of their holy animals and plants. This was particularly the case with the Assyrians, and the paintings of this race were very much like those of the Egyptians. I might, therefore, name some of the principal types which form the basis of Egyptian ornaments.

First, there are the buds and flowers of the lotus and papyrus plants (Fig. 2, p. 334), which were the symbol of the nourishment of the body and mind. Then the dung beetle or scarabæus. This insect has the remarkable habit of laying his eggs in excrement, with which it envelopes the egg, and of forming a little ball. The beetle draws this ball after it with his hind legs until the surface hardens. The ball containing the embryo of a new life, which the heat of the sun will awaken, was to the Egyptians symbolical of the globe, out of which new life would spring, and of the minuteness of the Creator's work.

Fig. 3. Piece of the Dress of an Assyrian King.

As the ancient Egyptians were sun-worshippers, their most sacred figure was the disc of the sun, mounting the sky on eagle wings. The Uraus serpent was the symbol of sovereignty over life and death, for the bite of this creature meant instant death. Beside these, many animals were sacred.

Another ancient State possessing culture was that of Assyria. The territory between the great rivers, the Euphrates and Tigris, was in early times the home of extensive industrial art. The Bible mentions the magnificence of old Babylon, and its circumference is said to have been about 40 miles.

In the ruins of great Assyrian buildings were found plates made of alabaster, which were used for covering the walls. The prowess of the kings was shown on these plates. These give us plenty of clues to a textile industry; for we are able to ascertain perfectly well the manner in which the Assyrians made patterns for dresses, carpets, and antipendiums. On these plates the Assyrians are represented as being dressed in long loose gowns with fringes and embroideries to represent beasts fighting, fantastic forms of animals, bodies of lions with human heads and wings, human bodies with wings and birds' heads.

Amongst these we see borders with stars, strings of roses, zig-zag lines, winding-curves, meandering lines, palmettos; and here also the disc of the sun with wings—the symbol of Assyrian sun-worship. A very characteristic ornament was the "Hom," the Tree of Life, which bears fruit like pomegranates.

The pomegranate plays a large part in the symbolism of many religions, as well as in the Christian religion. In ancient times it was the symbol of love: Jupiter makes the bridal Juno taste of pomegranates; Leah wanted to buy the love of Jacob—who loved Rachel better than her—with love apples, the smell of which animates love; and, lastly, the apple was the symbol of the generative power of nature, and was the forbidden fruit of Paradise. The Bible makes mention of weavings of an Assyrian character. Moses says of the makers of the ten large tapestries of the Tabernacle, which were ornamented with cherubim:—"Them hath [God] filled with wisdom of heart, to work all manner of work of the engraver, and of the cunning workman, and of the embroiderer in blue and in purple and in fine linen, and of the weaver" (Exodus xxxv. 35). About the official dress made for Aaron, Moses says:—"And they did beat the gold into thin plates, and cut it into wires, to work it in the blue and in the purple and in the scarlet and in the fine linen with cunning work. . . And they made upon the hems of the robe pomegranates of blue and purple and scarlet and twined linen" (Exodus xxxix. 3 and 24).

A drawing shows a piece of the dress of an Assyrian king, when sitting upon his throne (Fig. 3, p. 335). In the circles, surrounded with palmettos and pomegranates, the Tree of Life is standing, surmounting it being the disc of the sun with eagle wings. The figures are kings and priests, and those with wings are cherubim, with human and eagle's heads. The lions with wings probably represent subordinate gods.

A third great State of ancient culture in the far east of Asia is China. This empire has an important connection with the textile industry, being the native country of the most precious material for weaving, that is silk. In the year 2698 B.C. the consort of King Hongi, named Louitsen, is said to have invented the rearing of silkworms and the weaving of their threads. The strict custom of destroying with fire the dresses of the dead accounts for the fact that few or no remnants of old Chinese textile productions are preserved. Notwithstanding this, we are able to draw conclusions from modern drawings as to those of times long gone by. A great characteristic of the Chinese is their adherence to ancient customs and a surprising power of resistance to foreign influences. With regard to art the Chinese are neither progressing nor falling back. They employ objects of all possible kinds, such as clouds, the waves of the sea, groups of rocks, shells, vases, &c., and all the flora. The lotus flower of the Egyptians is often used, as is also the peony, the symbol of the sky and the earth, deriving from the former flower perfume and from the latter brilliancy. We also find a number of fantastically-shaped animals, of which the dragon is a frequent figure. (Fig. 4.) A marvellous creature, with the head of a chameleon, the horns of a stag, the claws of an eagle, and the tail of a serpent. This dragon is the

FIG. 4.—MODERN CHINESE SILKSTUFF.

symbol of supreme wisdom. Its empire is all space, above the mountain tops, among the clouds, in the underground depths, and in the air and the water. The dragon is the martial device of the Emperor and of the senior princes, possessing in this case five toes. The dragon of the junior princes not being so important has four toes, and that of the Mandarins only three.

The device of the Empress is the phœnix, a bird with a peacock's tail and a head covered with protuberances. It symbolises a long and happy life. The Chinese horse, or "Khilin," has the body of a stag, the horns and tail of an ox, and horse's hoofs. This marvellous creature appears in Assyrian art as a unicorn, and it may be traced up to the 13th and 14th centuries. Lastly, may be mentioned the Chinese lion, or dog, named "Fo."

All these fabulous animals, together with specimens of the vegetable kingdom, and some very elaborate line compositions, form the elements of the extraordinary designs which the Chinese make use of in the decoration of their stuffs.

FIG. 5. WOOLLEN MATERIAL, 5TH CENTURY B.C.
From Compte-rendu de la Commission Archéologique, à St. Petersbourg, 1881.

After considering the textile industry of the three oldest civilised nations in Asia and Africa, we turn to Europe and give our attention to the nation which laid the foundation of European culture, that is Greece.

Until 1879, we are only able to draw conclusions as to the designs on Grecian stuffs from the decoration of old buildings, and old pottery. Greek authors give a good deal of information upon the designs of these stuffs. Excavations made in South Russia, in 1879, have confirmed the supposition that no branch of industry or art has its own decorations, but the dominant style belongs to them all.

Amongst the articles found in the tombs, detailed and illustrated in the "Compte Rendu de la Commission Archéologique à St. Pétersbourg," in 1881, there were a number of fabrics; the age of which is denoted positively by inscriptions. From the tomb of a warrior of the 4th century a great cover, which was laid over the sarcophagus, was taken. It is about seven yards square. We see alternate mythological scenes and ornaments. This cover proves to be a Greek production, from the numerous inscriptions upon it in the Grecian language. The name Jocasta shows that scenes of the legend of Oedipus were being represented. The names Phœdra and Eulimene close by two women in violent motion, and the name of Atkaia point to the wrestling combat of Peleus with Thetis. The goddess Athene, armed with the protective ægis, and a lictor, returning from a chariot race, are also depicted on this cover. Another little piece of woollen material was found in a tomb, dating 5th century, B.C. It is decorated with small zig-zag, crosses, meandering lines, and similar motives (Fig. 5). In the same tomb, which contained the large cover, was found a piece of woollen material which was extraordinarily thin. One side of the fabric is bound with satin and the other with reps. The piece of stuff proves the great perfection of the Grecian textile industry. The patterns are woven upon a cherry-brown coloured ground in tapestry style. The design represents a series of five ducks with raised wings and heads, alternately turned to right and left. A beautiful dark green, whose brightness is very well preserved, is seen on the heads and necks. Other different fragments were found in the same place.

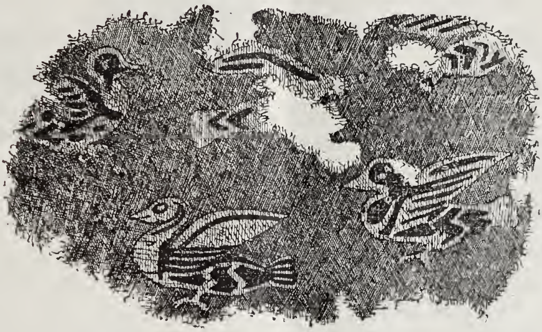


FIG. 6. WOOLLEN MATERIAL, 5TH CENTURY B.C.
From Compte-rendu de la Commission Archéologique, à St. Petersbourg, 1881.

As these preserved fragments of the ancient Greek weavers' craft are of the greatest value to inquirers, so numerous literary references convince us of the cleverness of the Greek figure weavers. Their productions were worthy of a place by the side of their other artistic works—being of a high degree of merit. It is impossible to quote all the

passages, but it may be sufficient to mention two of them.

Ovid, in his metamorphosis of Arachne, says it was a pleasure to observe Arachne winding the wool and curling and twisting it into fine threads. She contended with Pallas Athene in a trial of their skill in weaving. Each puts her loom in a separate place, and stretched the fine threads thereon. The combatants hasten to their work. Pallas Athene weaves the Castle of Cecrops, standing on the rock of Mars. Twelve immortals are seated on their thrones, in austere solemnity, with Jupiter in their midst. Neptune, the sea god, alone is standing, and, with his trident he strikes the unhewn rock, from which the salt water gushes forth. Pallas Athene is shown, furnished with the defending aegis, and having on her head a helmet, and in her hand a pointed lance. At the place where the lance has pierced the ground, a green olive tree, bearing berries, is sprouting. The work is surrounded by a garland. The gods look at it with astonishment.

It is very interesting to compare this woven picture, described by Ovid, with the splendid sculptured work, executed by the celebrated Greek sculptor Phidias, for the pediments of the Parthenon, now the temple of the goddess Athene, on the Acropolis.

England is fortunate enough to possess, in the far-famed Elgin marbles in the British Museum, the original remnants of this work of Phidias. This sculpture also shows the representation of the quarrel concerning the name of the town of Athens.

But Arachne wove the story of Europa carried away by the bull. The latter seems to be really living, and the sea to be heaving. In addition, Arachne wove Asteria seized by the flying eagle, the loves of Leda and the swan, and other similar scenes. An ivy garland went round the border, with flowers interwoven. Ovid reports, moreover, that Pallas Athene was not pleased with Arachne's work; on the contrary, she punished her, by changing her into a spider, ugly indeed, but a skilful weaver. This was Arachne's punishment for having had the temerity to remind the daughter of the father's amorous adventures. A passage in the Odyssey also gives a clear image of Grecian designs. Ulysses describes to Penelope the dress he wore on his departure to Troy. The dress of the noble Ulysses was of a purple colour, and rough in texture, with flashing embroidered front. A spotted doe is struggling under the forelegs of a savage-looking dog. The astonishment of all beholders is excited by the manner in which the dog embroidered in gold is strangling the doe, while glaring at

FIG. 7. STUFF OF THE 13TH CENTURY. (½ actual size

it most ferociously, the latter meanwhile endeavouring to regain its freedom. This embroidery is very interesting, because we find among the stuffs of the 13th century a very similar design (Fig. 7).

FIG. 8. PIECE OF SILK, B.C.
From "das Stil," by G. Semper.

Such weavings of Roman origin as have been preserved date from the time of the Roman emperors. A very rare little piece of silk—perhaps belonging to the time before Christ—is preserved in the Church of Valeria, at

Sitten, Switzerland (Fig. 8, p. 538). The design shows a female figure, sitting on the back of a sea-dog, and under the latter an acanthus stalk. This stuff from Sitten; the Greek fragments already mentioned as being found in Southern Russia; and perhaps two or three other little remnants in various museums, are the only known remains of textile products of the time before Christ.

To arrive at the place where probably the oldest weavings of the Christian era were produced, we must again return to the country which has shown itself so well able to preserve the treasures entrusted to it. I mean Egypt. In Sakkarah and Akhmîm, in Upper Egypt, large cemeteries have been discovered in recent years. The dead bodies contained in them were not enveloped in strips of linen, as were the old Egyptian mummies, but were dressed in the garments they had worn when alive. We obtain a complete picture of the costume of this period. But we are more interested in learning the materials of which the garments are made. There is the towel-faced material, which when used for costume was worn in the winter. In the height of summer, when steeped in fresh water, the peasants would use it to wrap round the wine amphora to cool its contents. They had also a kind of wool rep, a compact twilled woollen material with a woven broad purple stripe; woollen cloth, evidently woven over rods, looking like velvet with an uncut pile. But our greatest interest will be excited by the woven bands crossing each shoulder and running vertically down the front and back of the robe, and by the round and square pieces of cloth, the medallions, which were the signs of rank. These articles were woven in tapestry style, with many-coloured threads, in wool. There are ornamental and figure pieces in great variety; bull-fighters, slingers, bowmen, mounted hunters with lances, hunting lions and leopards, and a variety of animals, such as wild goats, hares, birds, &c. Further on, medallions with biblical scenes (Fig. 9, p. 540), perhaps the history of Joseph in Egypt; or another one showing Abraham about to sacrifice his son Isaac.

Not only were woollen fabrics found in excavating these tombs, but also silk materials. We find little designs, not larger than the size of a pea, composed of little lozenges, hearts, and clubs. Figs. 10 and 11 (p. 540), are large square designs in which card signs again appear. In squares or circles occur horsemen or dancing girls similar to designs on Persian fabrics mentioned later on.

At present, it is hardly possible to say positively whether these fabrics were manufactured in Persia, or whether they were woven in Alexandria, Antioch, or Byzantium. Similarly, we are not yet able at present to determine the age of these goods. At all events we have reason for supposing them to be some of the oldest preserved woven products of the Christian era, belonging to the time from the 3rd up to the 8th century.

Now let us consider the Persian woven designs. At the time when the Romans were losing more and more of their independence, owing to the enervating results of their social life, and the lassitude of their rulers; and when from these causes the Roman government was hastening to its ruin, the Persian empire in Asia was building up a new civilisation upon the ruins of a culture then long gone by. In the year 226 B.C. Artaxerxes I. took in hand the government of all Central Asia. He founded the family of the Sassanides, who reigned in Persia 426 years. The greatest prince of Persia was Chosroës Anurshirwan 531-579. During his reign, commerce, industry, and weaving of a high character flourished Some original fabrics, kept till the present day as covering for relics, prove the great perfection of this Persian textile industry. If we analyse the designs upon the Sassanide weavings, we mostly find large circles standing in rows one upon the other. The points of contact are covered with roses, smaller circles, and polygons. This is a very characteristic design, and one which occurs in Persian and Byzantine fabrics of the 4th up to the 12th and 13th centuries. In the church of St. Servatius at Maestricht there is exhibited a small collection of fabrics of the Middle Ages. Amongst them is a very brilliant specimen of Persian weaving skill.* A broad circle decorated florally, encloses two Persian kings hunting lions on horseback. Hunting scenes very often appear on Eastern fabrics, because the Orientals are great sportsmen, and we shall see similar scenes until the end of the Middle Ages. The riders and huntsmen are not always arranged in circles; we also see men on horseback, sometimes with wings, placed in rows without circles, or in squares or polygones, great lions gravely stepping in order one after the other, or two of them

* Figured in "Ornaments of Textile Fabrics," by Frederick Fischbach, plate 3 B.

FIG. 9. EGYPTIAN WEAVING FROM AKHMÎM. (½ of actual size.)

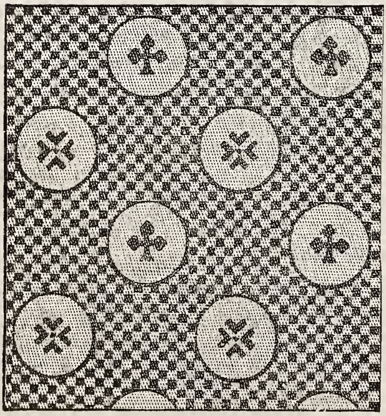


FIG. 10. SILK MATERIAL FROM AKHMÎM.[1] (½ of actual size.)

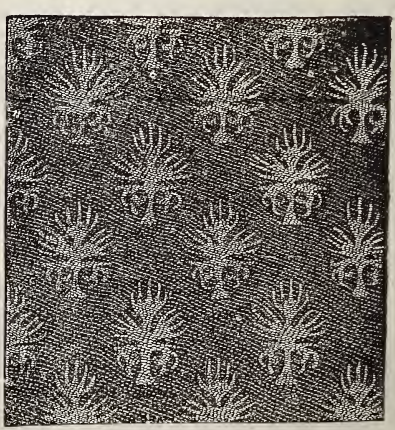


FIG. 11. SILK MATERIAL FROM AKHMÎM. (½ of actual size.)

facing one another (Fig. 12). Very interesting examples of Sassanide fabrics are preserved in the treasuries of the churches on the banks of the Rhine, and in Aix-la-Chapelle, in several museums, such as the South Kensington Museum in London, and in the Museum of Industrial Art in Berlin.

We now return from the Persian land of wonders to European ground, and consider the silk-weaving of Byzantium. This new capital, which, at the time of Constantine the Great had taken the place of ancient Rome, endeavoured to emulate the old city in all matters appertaining to art. In Byzantium, the artistic

FIG. 12. From "das Stil," by G. Semper.

capabilities of the Old World were concentrated. Here the flickering spark of art was fanned to set ablaze a new art-life later on; whilst in the Western countries, owing to the violent disturbances attending the migrations of tribes, the influences of art were decaying more and more. In the beginning of its development Byzantine, or early Christian art, was a hybrid formed by the influences of the Western nation, which ruled over Byzantium, and by those of the Asiatic races subjugated by the Roman. With the government of the Emperor Justinian I., 527-565, a new epoch was inaugurated, and a new style created.

The Byzantine style flourished up to the early part of the 13th century (1204). At this period the decline of this splendid and pompous style commenced, but the inhabitants of the Eastern Roman Empire continued under its influence until the time when the Turks conquered this once mighty Empire (1453).

The reign of the Emperor Justinian was the prominent feature of the Byzantine Empire, as well in art as in history. Justinian I., not without reason, has been compared with Louis XIV. Both showed the same activity and capability, both were animated by the same bigotry, both were under the influence of petticoat government, and in the States of both sovereigns ambition for military glory, and a great love of pomp, nourished by taxes, produced the same results. Justinian employed all the financial schemes of modern politics to swell the public revenues, such as every description of tolls, duties on eatables, state monopolies, &c. Of the latter, the monopoly of manufacturing splendid silk goods is particularly remarkable. The rearing of silkworms in Europe cannot be traced back earlier than the reign of Justinian. Before this time the silk was imported from India and China, in which countries its production was guarded as a great secret, and the export of eggs of the silk moth was attended with severe penalties. The legend runs, that two monks conveyed in their hollowed pilgrim staves some eggs of the silk moth, and seed of mulberry tree, so important for its nourishment, when returning from a pilgrimage from distant China in 555. These were the germs from which an industry was to be evolved, and to which Europe owes a large part of its present opulence.

Justinian was able to appreciate the great importance of silk weaving and silk industry. He brought into his own manufactories silk weavers from those countries which were in competition with him.

We have seen how the Persian kings of the family of the Sassanides established silk manufactories in the same manner as Justinian. They paid great attention to the silk trade, rightly valuing their favourable geographical situation, which placed them midway between the East and the West. For this reason Justinian engaged first-rate Persian weavers for his imperial factories. It followed, as a matter of course, that these weavers did not immediately resign their own tastes, and thus we find, especially in the earlier part of this period, great relationship between the Byzantine

and Persian drawings. Of course there was a reciprocal movement in this matter, because the Persian kings also made use of the excellence of the Byzantine textile industry at that time by engaging weavers from Byzantium. There is an additional factor in this likeness between the Persian and Byzantine woven designs; the latter also show us figured pieces surrounded by large circles.

In the treasury of the church at Maestricht there is kept a piece of stuff, which belonged to the garment of St. Servatius, the patron of this church, in which he was buried.* The figured part of this design is surrounded by connected circles having a diameter of a quarter of a yard. Within the circle two brothers stand upon a Doric column, perhaps Romulus and Remus, or the two Dioscuri,

FIG. 13. Original preserved in the Church of St. Servatius, Maestricht. (½ of actual size.)

Castor and Pollux. On each side of the column a bull is being sacrificed. Two angels pour out a libation.

According to Dr. F. Bock, a praiseworthy investigator and collector of textiles, this fabric is the only piece of silk which gives a representation of a heathen sacrifice of animals. The technical detail is remarkable. We observe four colours in the woof; the ground is dark crimson; the outlines of the floral ornament and of the figures are covered with dark violet purple; the carnation, and

* Figured in Fischbach's "Ornament." Plate 3A.

some parts of the garment, are woven in yellowish-white silk; and, lastly, green is employed on the garments, and for the floral ornament. We can assign the manufacture of this very interesting fabric to the 4th century A.D.; and it is quite possible that the material was really part of the dress of St. Servatius, judging not only from the design, which is characteristic of the period, but also from other reasons, such as the traditions attached to this rare piece of silk, and its discovery and preservation. A powerful argument is furnished by the great resemblance of the ornament, in the circumference of the circle, to the ornament similarly placed, which appears on a piece of silk found in a Coptic tomb in Egypt. The design is undoubtedly the same, and, as Coptic fabrics have been found with Papyrus documents, which are dated from the 4th century there is no reason to doubt but that this material, attributed to St. Servatius, did belong to him. This is the more probable, as that saint went on a crusade from Asia Minor to the north of Germany, Belgium, and Holland.

Another celebrated fabric is preserved amongst the treasures of the Aix-la-Chapelle Cathedral. Here also we see large connected circles, with diameters of over half a yard. The figured centre, a team of four horses, is sure to relate to the chariot races, which were so popular at the time of Justinian, that the two great political parties of Byzantium used to wear the colours of charioteers. Hence the name of the parties, "blue" and "green."

FIG. 14. Original preserved in South Kensington Museum. (⅓ of actual size.)

A scene very often represented in designs of the 7th and 8th centuries is that of a man fighting with a lion. (Fig. 1 .) It may be the fight of Hercules with the Nemean lion, or Samson strangling the lion, or, finally, the struggle of Christian martyrs with wild beasts in the Roman Amphitheatre.

It is not possible to describe here all the woven pieces made under the influence of Byzantine art up to the 13th century. It may be stated that most of the designs were composed of animals facing one another, and surrounded by graceful ornament. All possible varieties of animals were made use of. In old inventories of churches we find mentioned the chasuble with lions, the eagle dress, the chasuble with elephants, &c.

An interesting brocade, with pattern of lions, is preserved in the South Kensington Museum. Dr. Franz Bock, in Aix-la-Chapelle, one of the best connoissers of ancient textiles, says in his book "Die liturgischen Gewänder des Mittelalters," with reference to this design:—"If in Christian art the royal lion of the tribe of Judah represents our Saviour, which fact is undoubted, then in this design our Saviour would be Lord and Commander of the whole creation, and it would be possible to find a reference in this design to the Psalm: 'Thou wilt stalk across serpents and salamanders.'"

A cope with large eagles is preserved in Brixen Cathedral in Tyrol. On a red satin ground we see large eagles in a dark greenish black colour. The actual size of the eagles in the pattern, taken from one wing to the other, is 20 inches.

A most interesting pattern is to be seen on the splendid silk stuff, in which the bones of Charlemagne were enveloped in the Aix-la-Chapelle Cathedral. The ground colour is red, the elephants and ornaments white, yellow, blue, and green. The diameter of the circle is 32 inches. Besides these fabrics bearing the large designs, several remnants of materials are preserved, which show smaller patterns of geometrical construction. There are pieces of small octagons*, roses, little crosses, and such like. The quarrels of the image worshippers and image breakers in the 8th century perhaps had their influence upon figured textile design. Even art was outlawed, being considered an accomplice of idolatry. But this is a matter I leave to others.

Remains have been preserved of another class of silk goods, which have their interest from a technical point of view. Owing to the method employed in binding the warp and the weft, the finely drawn designs, composed only of outlines, merely appear as though engraved upon the shiny satin surface. It is very probable that these fabrics are also examples of Byzantine textile art. The period at which they were produced is determined by the places where they were discovered, and by the traditions attached to them. In the Cathedral of Xanten, near the lower Rhine, a yellow chasuble of St. Bernard, and in Mayence Cathedral, a green chasuble of St. Willigis are shown. In the Royal Museum of Industrial Art, at Berlin, and in the Royal Textile Collection, at Crefeld, are exhibited pieces of the garment in which the German Emperor Otho the Great (936-973) was buried (Fig. 5, p. 545). The dyeing of the materials forms a very interesting part of the examination of the Byzantine textile manufacture. Without entering into detail, it may be shortly stated that purple was the most valued colour of the Middle Ages. It comprised six shades of colour, from the darkest violet to the purest violet-red. The imperial purple possessed a deep, dark tone, like that of the violet flower. In the times of the Roman emperors the real purple from the *murex* shellfish was worth its weight in gold; the use of this colour was confined exclusively to the imperial court and the Church. The purple of Alexandria and Tyre has been famous from the earliest times.

The consideration of textile design subsequent to the decay of Byzantine art brings us to the art of the Mohammedans. With the spread of Islamism a great revolution of culture took place. Owing to the rapid propagation of Mohammed's doctrines, his adherents, within 100 years after his death, had obtained a footing eastward as far as the banks of the Ganges, and westward over all the northern part of Africa, as well in Sicily as in sunny Spain. The Arabs transported into their newly-conquered dominions not only their creed, but also their culture and science. In Spain splendid palaces arose, all the pomp and luxury of the East expanded, and industry and commerce reached a height never before attained.

In the same manner as in Spain, the Arabs exercised their industrial and artistic skill in the sea-girt Etnean island of Sicily. This grand era of textile industry did not commence until after the conquest of Sicily by the Normans. It bears the name at the present day of the "Saracenic-Sicilian" epoch of textile art, and a large number of splendid examples of this period are preserved in our churches and museums.

The Normans, in quest of booty and territory, took possession of Sicily in the 11th century. After settling there, their kings conceived the idea of augmenting their power by developing the resources of the country. This idea was fully carried out by the best of the Norman Kings, Roger II. (1101-1184). He knew how to encourage the rearing of silkworms and the manufacture of silk, which was carried on in Sicily by Saracenic weavers. Of great importance to the development of silk manufacture in this country was King Roger's campaign to Albania, the present Greece. He

* Figured in Fischbach's "Ornament."

led away captive all the men and women from Corinth, Thebes, and Athens he could find who knew how to weave silks, and carried them to Palermo. He built dwellings for them, and compelled them to weave for him and to improve the silk industry. In order to insure the prosperity of the latter, it was declared to be a royal monopoly. Mulberry trees were cultivated in all parts of Sicily, and silkworms were imported and reared with great perseverence to obtain raw silk.

An interesting royal silk factory was estab lished at Palermo. This factory (the so-called Hotel de Tiraz) was in the royal palace, and owed its foundation to the Kelbij Amirs, who ruled Sicily, as vassals of the Fatimas, in the 9th and 10th centuries.

A writer of the 12th century, Hugo Falcandus, draws the following picture of it in his description of Palermo :—

"It is impossible to pass over with silence the celebrated workshop adjoining the palace, in which silk is spun into different coloured threads, and these threads combined to form fabrics of several varieties. Here one can see stuffs made of single, double, and threefold thread, which are less expensive, and require less skill than those made of sixfold thread, more raw silk being used for the more substantial materials. Fabrics are ornamented with a circular design, requiring, for this reason, great skill and a high price. There are, also, numerous ornamental patterns of various kinds and colours, woven in gold and silk threads. To this class of goods the beautiful effect of the design is often illuminated by the brilliant flashing of precious stones."

Fig. 15. Garment in which the Emperor Otho was Buried. ($\frac{1}{2}$ of actual size.)

Under King Roger's supervision, the Hotel de Tiraz maintained its special character and excellence of work. A silk manufacture sprang up from it, which not only answered King Roger's expectations with respect to the increased prosperity of his country, but also had its influence upon the whole of Italy, as the industry got a footing there also, and laid

the foundation of the opulence and power, which were to accrue to the towns of Central and Northern Italy. A great quantity of splendid types of Siculo-Arab work, in the 12th century, enables us to form some conception of what manner of stuffs William of Palermo wished to speak of when he described the palace of Roger of Sicily :—

> " De drap de soie à or ouvres
> A œuvres d'or et à peintures,
> A maintes diverses figures
> D'oisiax, de bestes, et de gens.
> Les chambres furent par Dedans
> Paintes et bien enluminées."

Let us now examine the designs upon these fabrics, made at Palermo by the Saracenic and Greek weavers. We find that they used the same patterns as in their native countries. Symbolical animals, enclosed in large or small circles, in contact with one another, or by polygons, just as in the Byzantine work (Fig. 16).

In the Royal Textile Collection at Crefeld there is preserved a little fragment of the stola in which the bones of King Roger II. are enveloped in his tomb in Cephalo, near Palermo. (Fig. 17, p. 547.) It is quite possible that

FIG. 16. BYZANTINE WORK. ($\frac{1}{2}$ of actual size.)

this splendid purple coloured fabric was manufactured at Byzantium and brought home by King Roger after his campaign against Emanuel of Constantinople (1147). Other samples of this period bear more distinctly the character of Saracenic fabrics. The designs upon them are composed of stripes in different colours, red, green, blue and white, with ornaments of gold threads. In the stripes we often see Arabian inscriptions, A rare fabric, which came from the Church of St. Mary, at Danzig, shows an Arabian inscription, "assultan al alim," which means the wise Sultan.

At Ratisbon are two surplices, which the German Emperor Henry VI. presented to the Ratisbon Cathedral. He inherited Sicily by his wife Constance, the heiress of the Norman crown. With this Emperor the vestments of the Norman kings, manufactured in the Hotel de Tiraz, and

bearing Latin and Arabian inscriptions, passed into the possession of the German Imperial family, and until 1797 were the official robes of the Emperors of the Holy Roman Empire of the German nation. The designs upon the two Ratisbon surplices are also striped in the same way as those already described. The Arabian inscriptions on these fabrics are very important. One of them means "Glory, victory, and long life." The other proves, without doubt, the origin and age of these materials. It runs: "This holiday garment was made by Master Abdul Aziz, in his factory, for William II." This was a Norman king, reigning from 1166-89. Apart from royal robes, the most handsome stuffs were devoted to the manufacture of the dresses of honour which Mohammedan princes were pleased to bestow on those who had succeeded in winning their Royal approbation. A welcome ambassador, the bringer of good news, a court favourite, a servant, who had done something (or nothing)

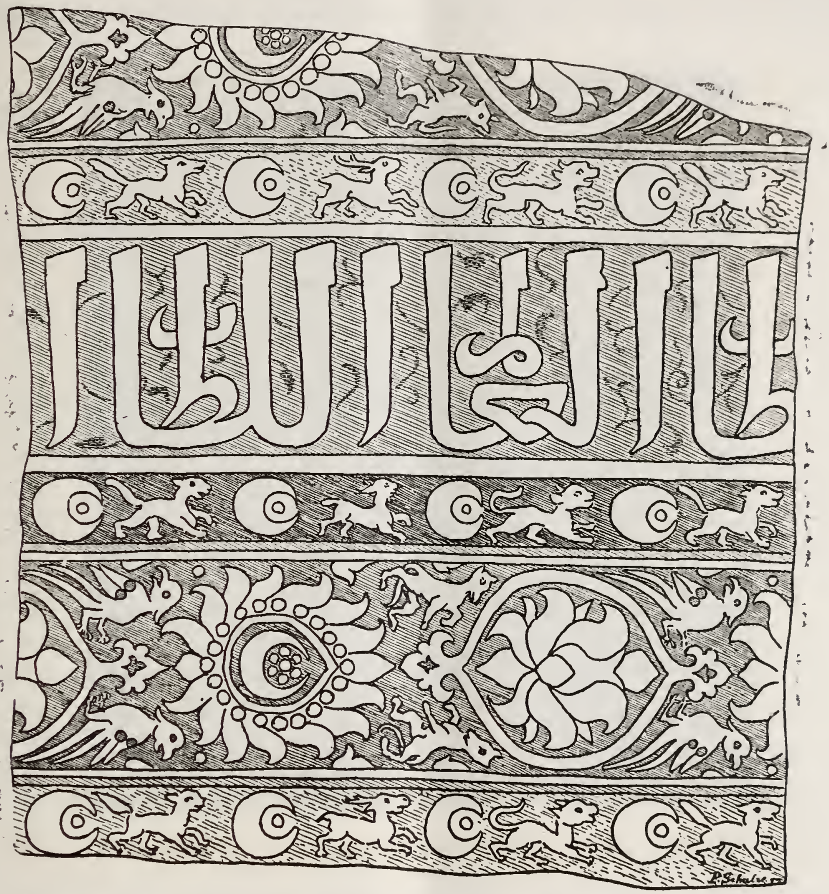


FIG. 17. ARABIAN INSCRIPTION ON A FABRIC IN THE CHURCH OF ST. MARY, DANZIC. (½ of actual size.)

that pleased his master, would be so rewarded, the robe being appropriate to the rank of the person to be thus distinguished. To give the wrong dress would be like bestowing the Order of Saint Michael and Saint George on an Indian officer, or the C.I.E. on an Australian—as is said by Mr. Stanley Lane Poole, in his clever book about the art of the Saracens in Egypt.

The ornamental use of letters is a characteristic of Islam art. Mohammed, in his intense eagerness to suppress the worship and making of idols, has repeatedly pronounced in the Koran a strict prohibition against making any images of created beings. He considered such acts to be an encroachment upon God's omnipotence. According to the words of the prophet, the creations of unbelievers in this world will mount upon their backs in the Day of Judgment, with horrible forms and distorted faces, and the unbelievers will be forced to bear this horrible burden for ever.

To compensate for the loss of figured patterns, the skilful Mussulman took a very sensible course in conveying, with the assistance of his letters, so well capable of this treatment, the ideas expressed in other styles by allegories and symbols. Thus we find the walls of mosques and palaces richly decorated with sentences from the Koran and holy books. Their woven goods also show the employment of letters in their designs. However, the subtle expounders of the Koran soon found a means of evading the strict letter of the law, and admitted a more lenient interpretation of it. After this only naturalistic imitations of living creatures were considered unlawful, whilst a conventional treatment, which nearly represented the genus of the creature, as well as fantastic forms, which owed their origin to the inventive minds of the Orientals, were permitted. The employment of Christians to weave such unorthodox designs as beasts and even human beings, however, was in itself a salve to the Moslem conscience; for the Christian weaver, and not the Mohammedan wearer, might be expected to receive the punishment. Similarly, the prohibition against the weaving of silk dresses, which Mahomet considered should only be worn in Heaven, was held not to extend to the use of silk fabrics with a linen warp; and the prohibition against the drinking of wine is to-day not referred to the drinking of champagne, because Mohammed, who did not yet know this noble drink, was unable to forbid it.

FIG. 18. DESIGN WOVEN IN GOLD THREADS. ($\frac{1}{2}$ of actual size.)

In the textile fabrics, made by the Moors in Spain, we can see abundant evidence of their strict avoidance of figure subjects. The Arabs, with their peculiar capacity for mathematics, preferred geometrical designs, and such composed only by ornaments and conventional flowers. These designs might be the precursors of the splendid pomegranate compositions on the velvet, silk, and brocade stuffs, which were manufactured in the 15th century in Northern Italy. We learn from various writers how important Moorish manufacture in Spain was from the 10th to the 15 century. The towns of Almeria, Granada, Cordova, and Seville were particularly famous for their productions. In Seville 60,000 looms were said to have been active, whilst in

another district nearly 3,000 localities were engaged in the art of weaving.

The combined work of the Greek weavers, transported to Palermo by Roger and the Saracens, introduced a new style of textile designs, which by the skilful combination of graceful line and floral ornament with figure drawing—appreciated from the earliest times by Oriental taste—form the most interesting and attractive textile products of all ages. Elegantly-drawn tendrils form the groundwork, on which move slender and lithe-limbed animals (Fig. 7, p. 538). The Mussulmans coming over from Africa brought along with them a knowledge of the fauna of that vast continent: its giraffes, its antelopes, its gazelles, its lions and elephants; they knew the parrot of India, and the hunting lion—the cheetahs—that were found in Asia; and, when the stuff had to be wrought for European wear, imaged both beast and bird upon the web, at the same time that they wove a word of greeting in Arabic, to be read among the flowers. The Grecian new-comers brought fresh designs, which were adopted sometimes wholly, at others but in part, and mixed up with the Saracenic style. Human figures are plentifully interspersed; men, and more often maidens, hunting animals, are enclosed in characteristic surroundings, such as castles, shells, and nets, like the bewitched princess in the contemporary fairy tales of the Arabian Nights.

It is interesting to learn that these designs often have a symbolical meaning. For instance, a lion seizing a duck pursued by an eagle means that the possessor of this garment was valiant enough to snatch the booty from the claws of the eagle, the eagle signifying luck and riches, the lion, power and government.

From a pattern upon a piece of silk of the 13th century, showing a lion and hoopoe,* it may be inferred that the fabric belonged to the robe of a strong and wise sovereign, since the hoopoe signifies wisdom. Moreover, a little inscription in the narrow border of the stuff says—"The Wise."

Another design, shows a woman catching a hare with a net, and holding by a chain or cord a hound and a spotted cheetah. Beneath this we see a woman with an eagle. From Arabian symbolism we learn (from Professor Karabacek, in Vienna) that the catching of the hare signifies opulence, marriage, and increase of family. To dream of riding on an eagle's back foretells riches, and, if a person should see a woman carried on an eagle's back, he will eventually arrive at government.

Another design of that period, often used in Catholic churches, is the following:—Two stags, fastened with chains and turning their heads to heaven, kneel on a flowery ground, surrounded by large connected hexagons. Dewdrops and sunbeams fall from the disc of the sun, which is partially hidden by clouds, where two eagles are sitting. In this pattern the stag is supposed to be the symbol of the human soul, weary of life, and yearning for delivery from its mortal body. We shall not be mistaken if we find in this interesting design a reference to the beautiful words of the 42nd Psalm—"As the hart panteth after the waterbrooks, so panteth my soul after thee, O God."

In another stuff a lion steps from the winged disc of the sun, holding in its claws a little animal. Another design shows a fountain, the structure being decorated with dragon heads from which hang scoops. Two girls carrying hares stand at the side of the fountain. Hounds and cheetahs lap the water flowing from the basin. Lastly, may be mentioned an interesting design, woven in gold threads, in which we see alternate repititions of stars, and a twisted ribbon bearing an Arabian inscription, above which a pigeon is flying underneath a large crown (Fig. 18, p. 548). We are thus able to discover a great number of interesting particulars in these fabrics.

But let us pursue the advancement of weaving in Europe. Whilst at the Hotel de Tiraz, at Palermo, these splendid silk fabrics with gold thread designs, those magnificent velvets and those embroideries, bearing precious stones in gold settings, were being manufactured, we see at the end of the 13th century the towns of Italy enter into competition with Palermo, and thus especially as regards those towns in the North of Italy, rose to great power and affluence.

Let us give our attention to the political situation at that time. I have already shown how the advancement made in textile production by some countries was due to political causes, and how artistic taste was affected by the same events.

The first town of the Italian continent to produce textiles of any importance was Lucca. It is mentioned in this connection in a manuscript so early as 1248. Manufacturing was carried on there to a large extent; the citizens

* Figured in Fischbach's "Ornament." Plate 29.

despatched their products to Paris, Bruges, and London. But commerce and industry were soon interrupted by civil wars of a sanguinary character. Owing to this cause, many clever workmen quitted Lucca and settled in the neighbouring towns: Milan, Florence, Bologna, Venice, and Genoa offered refuge to these fugitives, and laid claim to their skill.

The many difficulties which had to be overcome in the introduction of this complicated industry, such as obtaining of raw material and the technicalities of weaving and dyeing, gave no opportunity at the commencement for the creation of new patterns. The draughtsmen of the Italian towns, like those of Sicily, seem to have thought themselves bound to follow the style hitherto in use, brought by the Saracens, of figuring parrots and peacocks, gazelles, and cheetahs. Therefore, it is difficult to say for certain to which place of manufacture the

FIG. 19. ITALIAN FABRIC OF THE 14TH CENTURY. ($\frac{1}{3}$ of actual size.)

patterns of this period belong, and it is not until the middle of the 14th century that the differences in style appear more obvious owing to the advent of the new Italian ornament. It is true that the Italians used the Saracenic designs, but they paid no attention to their symbolical meanings; they thonght it sufficient, by copying animal figures and borders, bearing inscriptions and floral ornaments, to imitate similar designs upon the Saracenic weavings, which were valued so highly at that time. They would take a group of animals at random, surround it with secondary ornamental work, and add to this examples of their own style of ornament. Thus we see animals and plants mingled together with fantastic forms—cartouches, scutcheons, crowns, castles, fences, fluttering ribbons, and so forth.

In some cases the designs upon the Italian fabrics of the 14th century also admit of a symbolical interpretation, as is shown in Fig. 19. The dog, the symbol of the human soul, has been freed from this mortal

life, as indicated by the broken chain; the eagle, the symbol of Divinity, having descended from heaven to break the chain, now steers the soul to the abode of the blessed, and this action takes place under the shade of the great and mighty tree of the church. This design was probably made for the use of funerals.

That brilliant fabrics, with their splendid and interesting designs, influenced the poetical art of that time, and the songs of the German minstrels, is proved by the fact that, in the lay of the Nibelungs, the description of splendid garments occupies the seventh part of it. In the epopee Parzival, by Wolfram Eschenbach, there are high-flown descriptions of a great number of delightfully patterned weavings, with details of their names and origin.

But, on the other hand, songs and legends have also given inspiration for interesting designs. One pattern shows a maiden standing on the battlement of a castle, and holding with her hand a falcon endeavouring to fly. In another pattern we see a maiden coming out of a large flower, on her hand a falcon with bells on its feet, and by her side a dog fastened with a cord. Mr. F. Fischbach thinks the following song may be referred to these patterns:—

Ich Arme einen Sperber lieb zu haben!
So liebt ich ihn, dass Sehnsucht mich verzehrt.
An meinem Ruf schien sich sein Herz zu laben,
Oft hat er Kost aus meiner Hand begehrt.

Nun stieg er auf so stolz und so erhaben,
Viel stolzer als er sich mir je bewährt.
In einen Garten flog er über'n Graben
Und eine andre Herrin hält ihn werth.

Wie reicht ich dir mein Sperber, Leckerbissen!
Goldene Schellen gab ich dir zu tragen,
Dich frendiger zur Vogeljagd zu wissen.

Nun flogst du hin und lässest mich verzagen,
Du hast die Bande frevelhaft zerrissen
Just da du meisterhaft verstandst zu jagen!

In the further development of textile designs the slender and graceful tendrils were converted into knotty branches forming a pointed oval, in the middle of which was placed a group of animals in the Saracenic style. The characteristic ornament of the 15th century, the pomegranate, is made to sprout out from one of the angles formed by the contact of the branches. At first the pomegranate is small, and takes a subordinated position, the animal figures being predominant; but, later on, the size of the pomegranate is increased, and that of the animals diminished more and more.

Before we turn to the fully-developed pomegranate pattern of the 15th century, another class of patterns, belonging to the end of the 14th century, may be discussed. Here, again, we have those slender elegant tendrils with little leaves covering with profuse growth the ground of the material, and often mingled with little birds, hares, dogs, leopards, stags, elephants, dragons, camels, &c. Owing to the influence of the Gothic style, the round arched leaves gradually disappeared, and the vine-leaf and bunches of grapes often appear as a characteristic floral ornament of this epoch.

Fig. 20. Artificial Representation of Fruit.
($\frac{1}{3}$ of actual size.)

At the end of the 14th century, animal figures disappeared totally from design, and the pomegranate was transformed into the imposing pattern which, during the end of the 14th, the whole of the 15th and the first quarter of the 16th century was a prominent feature. (Fig. 20). It is composed of a fruit-like ananas

or pine-apple, placed in a cluster of leaves, from which flowers and leaves are sprouting, the whole being surrounded by ornaments of different kinds. The arrangement is the same in all patterns. The pomegranate is placed in the centre, as a symbol of Christian love, and is surrounded by blossoms and fruit; the whole being symbolically interpreted to mean that love, by the aid of faith, brings forth the fruit of everlasting life. The rose, with five, six or nine leaves, which surrounds the pineapple, is surmounted by crowns: the reward, which charity receives in Paradise. The thorny branches, plaited together, tell us of the crown of thorns, and remind us that only by pain and struggle is the victory gained which brings the crown of eternal life.

A very interesting development of the pomegranate pattern appears about the end of the 15th century. Broad ornamented stems take an undulating upward course, and on either side branches bearing blossoms, leaves, and little pomegranates are disposed.* They were the fashion of the Burgundian Court in the latter part of the 15th century, where the use of an immense mass of material made the employment of these gigantic patterns possible. In the patterns of this time we see ladies dressed in robes of many folds, and with a long train which was looped up and carried on the arm. The noblemen of the Court of Charles the Bold were dressed in large gowns, which, on account of their extravagant length, fell to the ground in folds. Even the saints, the figures of Biblical History, were represented by the artists of those times as being dressed in the rich velvets and brocades of the Burgundian period. In the large altar picture in the Cathedral of Cologne, the holy men are marching in the

FIG. 21. EUROPEAN DESIGN OF THE 14TH OR 15TH CENTURY. ($\frac{1}{4}$ of actual size.)

* Figured in Fischbach's "Ornament." Plate 12r.

midst of their splendid suites, as though they were Dukes of Burgundy, while the Holy Virgin is depicted in gorgeous festival garments of the Burgundian Court. Naturally the expense attending the weaving of such material was immense, and it is not to be wondered at that an author of those times should write about this pomp and luxury in the following terms :—"The nobles are completely enveloped in gold and silver, velvet and silk, and satin and taffeta. They exhaust their mills, their meadows, fields and woods, in short, their revenues, in order to purchase dresses; the gorgeous ornaments upon which, composed of embroideries, laces, tassels, fringes, chains, &c., often considerably surpass the cost of the material."

Although these splendid fabrics were produced in Italy and in the East up to the 14th century, we find that in the 14th and 15th centuries, owing to the emigration of Italian weavers to France, Flanders, and Switzerland, the lucrative art of weaving began to obtain gradually firmer footing in these countries also (Fig. 21, p. 552).

FIG. 22. VASE PATTERN. (⅓ of actual size.)

In France more especially, the kings attempted to attract the weaving artists by means of charters and privileges, and to settle them in the towns of that country. Amongst these towns, Lyons took the first place, and rapidly increased, and with its magnificen productions soon became a dangerous competitor with the other manufacturing towns. This was in consequence of the extraordinary favour and protection which these towns enjoyed from the government. We are told that, in the middle of the 16th century, Lyons gave employment to 17,000 silk weavers; about the year 1675, to from 25,000 to 30,000; and

when at its best, in the latter half of the 18th century, to 80,000 persons.

Now let us consider what kind of designs appear on the manufactures of Lyons, Flanders, and Italy in the 16th century. It has already been shown by examples how the change from one style to another occurred. For instance, the change from the animal patterns to the pomegranate patterns. In the same way we may follow the gradual variations of the latter, until at last a new motive displaces this pattern, which, after having fulfilled its task as a link of this connected chain of textile designs, itself gives place to the new order of things. Just as we occasionally find in some of the fully developed pomegranate patterns, small animals, relics of the textile design of the 14th century, so we find the new characteristic feature of the 16th century pattern to be the vase in the pomegranate patterns of the 15th century. This ornament makes its first appearance in a very modest way; but gradually increasing in size, it finally displaces the pomegranate itself, and maintains its ground for some length of time, amid surroundings of the most varied nature. The thorny branches and the rose change into the sharp-pointed oval enclosures of branches, or of elegantly-drawn extended leaves, which are united at the point of contact by calyxes, crowns, &c. In the middle of this oval enclosure the vase is placed, and we see the little blossoms and flowers, which were derived from the pomegranate proceeding from the vase. The fabrics which bear these patterns are woven in a very splendid manner. They are, for the most part, brocades with a ground of red satin. The design is formed by a yellow and white woof, which is joined with a warp of red silk in twilled fashion, thus giving a very soft warm tint to the material, This effect is still more enhanced by a thin strip of silver interwoven with the fabric; this combined with the yellow and white silk threads, gives a rich metallic lustre, with the changing hues of gold and silver. In several patterns we see alternate rows of vases and pomegranates always enclosed in the same way, or rows of vases without enclosure, and little birds sitting on the branches (Fig. 22, p. 553). The Renaissance, with its more elegant forms, produced the most varied compositions of the vase pattern.

The great revolution in fashion which followed the introduction of the Spanish styles of dress, did not fail to have an effect on the patterning of dresses. The narrow folds and slashings of the garments required small patterns, which merely relieved the ground, but laid no claim to attention on their own account. The tendrils and ribbons, instead of filling large spaces occupied much smaller ones, in which a small palmetto, derived from the large designs of the 15th century, took the place of the large flower vase. The patterns are composed of elegant surroundings, enclosing symmetrical forms, such as the pomegranate or little flower vases, or lastly, little clusters of flowers, formed by three or five stalks bearing blossoms and leaves. The colours now are less brilliant. The period of the religious quarrels produced by the Reformation was a more serious one. Men's consciences were awakened, and this earnest time was reflected in the cut and colour of the garments. In velvets especially, the subdued tints, added a wonderful effect.

Fig. 23. Transition Design, 16th and 17th centuries. (½ of actual size.)

During the period of transition from the 16th to the 17th century, the surroundings of little patterns underwent a change, and to some extent disappeared. We can discover the former existence of these surroundings in small branches or parallelograms, united diagonally. The calyxes, which formerly united the branches, being separated from them, and standing self-dependent; the symmetrical form, previously standing in the centre, is displaced by an unsymmetrical branch with blossoms and leaves (Fig. 24, 25, p. 555); finally, the remaining part of the surroundings disappear altogether, and the typical pattern of the beginning of the 17th century is complete. It is composed

of the unsymmetrical branches, with blossoms and leaves, which appeared in the last variety of surroundings. They are put in series, leaning alternately to the right and left. The style of the drawings and the detail of the plant forms are given with much variety, as well as the size of the branches bearing the flowers, which may be seen from two to ten inches long (Fig. 26, p. 556). This pattern is called "fleurs semées," that is to say, "strewn flowers."

But the more we advance in our researches, the greater number of varieties of textile designs we shall meet with. On the whole, greater freedom is to be remarked in the general construction of the designs, as well as in the treatment of the simple forms, which approach more and more a realistic conception. Under the influence of the baroque and rococco styles with their caprices, which disregarded a distinct and constructive arrangement of patterns, the originality, which was periodically common to the patterns of former times, is lost. We see a multitude of designs, which are somewhat alike one another in their character, but of which we miss the common motive, which used to be continually repeated in the former designs; as, for example, the pomegranate in each pattern of the 15th century.

FIG. 24. TRANSITION DESIGN, 16TH AND 17TH CENTURIES. (½ of actual size.)

The important lace manufacture, which flourished in France, more particularly under the Minister Colbert, in the latter half of the 17th century, introduced a variety of very splendid woven designs. They are composed of flowery ornaments, spreading out in the shape of a fan, and intersected by interwoven ribbons of lace, very cleverly imitated. The so-called "lace patterns" betray the brillancy and luxury of the time of Louis XIII. and XIV.

With regard to their technique, the velvets of this period are very interesting. The ground is uncut velvet, and the patterns are shown by the cut velvet, and are surrounded by an outline of uncut velvet somewhat higher than the ground velvet. On the velvet of the 15th century cut velvet of two different heights appears on one fabric, and in the stuffs of the 16th century we learn the difference between the cut and uncut velvet, requiring for its manufacture three different rods: one rod for cut velvet, and two rods of different sizes for the uncut velvet of the ground and of the outline. This fact is a remarkable one.

FIG. 25. TRANSITION DESIGN, 16TH AND 17TH CENTURIES. (½ of actual size).

Besides these fabrics, which only show small patterns in consequence of the narrow Spanish costume which was worn all over Europe at this period, fabrics with large patterns were manufactured for hangings These materials preserved their symmetrical character for a much longer time than did dress fabrics. We find the vase appearing also in these designs often of a large size, and surrounded by graceful tendrils, frequently filled with birds, and quadrupeds, and basket of flowers. Horns of plenty, with surrounding fruit, take the place of the vase in some instances.

Other motives, having their origin in far Eastern Asia, appear in the reign of Louis XV. About the year 1720, Louis XV. sent an extraordinary embassy to the Chinese Emperor, bearing valuable presents, and under instructions to co-operate in trade relations, and to revive such as already existed. In return for this politeness, the Chinese Emperor selected splendid presents for the King of France, composed chiefly of beautiful pieces of porcelain, lavishly decorated with Chinese figures and ornaments. This occurrence rendered Chinese style fashionable in the upper circles of France for a short time, and the originality of this distant nation in their style of ornament appeared in the textile designs of this period — Chinese vases, the characteristic dragon, landscapes with the curious Chinese perspective, pig-tailed sons of the Chinese Empire in boats, and so on.

Contemporary with these patterns after Chinese style, a noteworthy feature was the

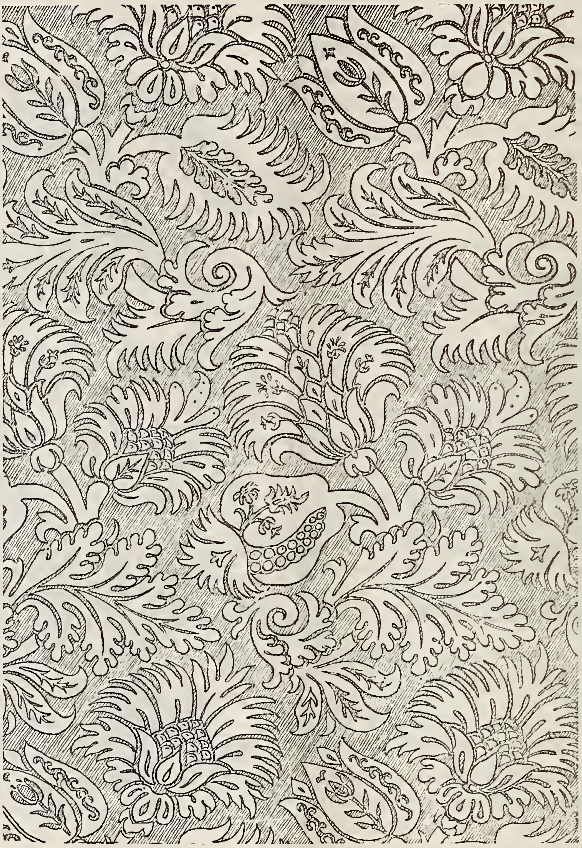


FIG. 26. FLOWER PATTERN, 17TH CENTURY. (1/3 of actual size).

use of plant forms drawn from nature. Flowers and leaves are rendered with the full effect of light and shade, and the natural colours of the flowers are imitated. The rose is used for choice, but fruit also, cherries and plums; in fact, a profuse flora in all possible fantastic forms, together with parts of architecture, cascades, shells, rocks, &c., served as models for the textile patterns of this time. A very good effect was produced by supporting the many-coloured floral ornament by a fanciful ornament woven in gold thread, by means of which the whole composition acquires a peculiar silhouette effect. Textile design has here areched its highest point, both in a capricious choice of motive, in combinations of brilliant colours, and in the richness of the bindings.

In the time of Louis XVI. these grand designs, admirable notwithstanding their quaintness, disappeared and gave place to patterns, which as regards delicacy of composition and softness of colour leave nothing to be wished. The large bunches of roses are diminished to

very small elegant nosegays shown upon a white ground with narrow stripes. The colours are reduced to such an extent that they no longer remind us of the preceding luxurious and splendid coloured ornamentation. These small patterns are intermingled with a variety of hunting, fishing, music, and such like symbols; fluttering ribbons, festoons, fruit baskets, &c., appear in the intervening spaces. They are the reflection of a period when ruin was approaching and when no energetic effort was possible. The designs on the textiles are a faithful mirror of the trivial social life of that time. But this state of things did not last for long. Probably in consequence of the excavations at Herculaneum and Pompeii motives were furnished for woven designs, which were taken from the wall paintings of classic antiquity. They bring us, after the desolation which the French Revolution spread over art, science, industry, and trade to the style of the first French Empire, which found its opportunity in the imitation of the antique.

Thus having brought before you the changes of pattern and style from the earliest days to the beginning of the present century, I discontinue my researches. If we examine the rich collections of antique woven fabrics, which now are established in many towns, we shall be astonished by the manner in which our forefathers could produce wonderful effects with very insufficient mechanical assistance. And now the problem is left us of studying the rich treasures hoarded up in textile museums, and of making use of them for the textile industry, which, as we have already seen, is so very important to the welfare of entire countries and towns.

To encourage all these endeavours, and to bring to notice all the beautiful and interesting subjects for investigation which this subject offers, these remarks have been made; but they do not in any way pretend to have dealt exhaustively with such a very extensive subject.

The originals of Figs. 4, 7, 9, 10, 11, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26 are preserved at the Royal Textile Collection at Crefeld.

DISCUSSION.

The CHAIRMAN read the following letter he had received from Mr. C. Purdon Clarke, C.I.E., Assistant Director of the South Kensington Museum:—

South Kensington Museum, S.W.
11th April, 1893.

MY DEAR WARDLE,—It is with great regret that I write to inform you that, having to preside at another meeting, it will be impossible for me to attend at the Society of Arts to-night, to hear Herr Schulze's lecture upon the "Development of Design in Textiles." The work that Herr Schulze has been doing for some years past has been of the highest utility to students of the "History of Ornament;" and he has fully availed himself of the privileges accorded by the liberal and enlightened administration of the Crefeld Museum to make several journeys to England, bringing with him historical examples for comparison and exchange; and, in addition, has favoured us, last year at Manchester, and will again this year in London, with lectures on the valuable results of his researches. It has been the effort of museum directors all over Europe, for years past, to struggle against the classifications of text-book writers of the earlier part of the century, who, knowing only a few localities and periods of ancient manufacture, ascribed everything to a limited number of places of production. Professor Schulze has thrown a strong light on these dim ages of the past, and the collection of historical examples is before us, to vouch the accuracy of his conclusions.

I remain, &c.,

C. PURDON CLARKE.

Sir GEORGE BIRDWOOD, K.C.I.E., said he responded to the invitation of the Chairman to open the discussion, not to criticise the paper that had been read, but because he felt constrained to express his grateful appreciation of it. Professor Schulze had favoured them with an admirable academical demonstration, by means of a series of selected types, of the historical evolution of the prevailing pattern-designs used throughout Europe in the present day. Professor Schulze had treated the subject with intimate technical knowledge and with great learning, particularly in connection with the designs illustrating the textile manufactures of the West during the Middle Ages and the Renaissance. In a descriptive paper like the present, every paragraph suggested some remark, and it was quite impossible to criticise it in detail without almost exceeding the length of the paper itself. One general observation, however, he would make, and that was in opposition to Professor Schulze's statement that dress originated in the instinctive desire to be attractive. He, on the other hand, believed that dress, in its origin, was entirely ritualistic; and this seemed to him to be proved by the practice of tattooing, from which the rich figurative vestments of kings and priests have, at least over the greater part of the world, obviously been derived. The practice was once universal, and is still widespread. Where it yet survives, it is invariably ritualistic; indicating the relation of those so "stigmatised" to their tribes and tribal divinities. That is to say, the typology of tattooing, as still practiced, is invariably totemistic, and mythological, its mythology

most frequently being of cosmological significance. And this was always so. In Genesis iv. 15, it is said:—"And the Lord set a mark upon Cain lest any finding him should kill him." In Ezekiel ix., 4 and 6, in the vision foreshadowing the destruction of Jerusalem for idolatry, a "mark" is set on the forehead of the men who remained true to Javeh, that they might be spared when the idolaters were slain "utterly, old and young, both maids, and little children, and women," and without sparing or pity. In Galatians vi. 17, St. Paul says:—"For I bear in my body the marks [στίγματα—literally, "'prickings with a needle"—tattooing] of the Lord Jesus;" and in the Revelation of St. John the Divine, xiii. 16, xiv. 9, 11, *et cetera*, we have repeated references to the mark of the beast, and to the mark on those who overcome the beast. Here the word invariably used is χάραγμα "a mark engraven" or "imprinted." The Hebrew word used in Ezekiel is *tau*, which is the Egyptian sign of the male element in nature and of life.* Again, Herodotus, ii., 113, in the Egyptian account of the flight of Helen with Paris, says that on reaching Egypt their attendants went off to the temple on the banks of the Canopic mouth of the Nile, and there dedicated themselves to Hercules; in sign thereof "receiving certain marks on their person;" and thus delivering themselves from the service of the guilty fugitives. The historian adds:—"The law still remained unchanged to my time." This ritualistic tattooing was early forbidden by the Jews, probably out of opposition to the Egyptians, as is seen in Leviticus xix. 28:—"Ye shall not make cuttings in your flesh for the dead, nor print any marks on you: I am Javeh;" and Ptolemy Philopator [B.C. 222-205], in his malignant hatred of the Jews, forced them to be tattooed with ivy leaves in honour of the God Dionysos, whose ivy leaf he himself bore tattooed on his forehead. Those who did not submit to the idolotrous brand, as the Jews deemed it, were outlawed. Herodian tells us how the ancient Britons were painted with representations of the heavenly bodies; and among the savages seen by the early European navigators along the coasts of the Americas, and in the South Seas, the tattooing was always found to be of this ourano-graphic description. Now we know from the Orphic Hymns that the spotted leopard's skin, or the spotted deer's skin [compare the spotted deer's skin worn by the Hindu Siva], worn by the worshippers of Dionysos symbolised the shining frame of the spangled heavens, and the golden girdle the stream of ocean, and the crimson robes intertissued with gold the life-giving light and heat of the glorious sun. Here the passage from tattooing to dress is clearly indicated, and the ritualistic origin of, at least, sumptuary vestments. Similar evidence is afforded by the descriptions of textile fabrics given by the most ancient of classical writers; such as that in the Ion of Euripides:—"And taking sacred tapestries out of the coffers, he [Ion] formed with them an awning [on the slopes of Parnassus], a wonder to behold. First, he took a splendid garment for the roof . . . and these were the woven figures pourtrayed on this texture. Heaven was there, collecting the stars within the Ether; and the Sun driving his horses to the last waning light of day, and drawing with him shining Vesper; and black-robed Night driving her two-horsed chariot . . . and the stars following her. The Pleiades were there, travelling through the mid-sky, and sword-bearing Orion. And above was Arctos moving round and round the gilded pole; and the circle of the full Moon, divider of the months, and the Hyades, the sign for sailors, and the Morn chasing away the stars. And for the sides [flaps] he placed other weavings of barbarian workmanship, well-rowed ships drawn in array against the Greeks and savage men, and hunting on horseback, and the chase after stage and fierce lions. And for the door [flap] a [tapestry of the autochthonous] Cecrops rolling in his dragon folds." He quoted the whole passage to show the identity of ancient classical pattern-designing in textiles, with that still being everywhere pursued in Anterior and Southern Asia. The Mohamedans, following the Jews, rejected tattooing, but the fellaheen in Egypt, and the ryots in Syria, and certain of the women in Persia also, still tattooed themselves. Many of the aboriginal tribes of India, and some of the Burmans also, followed the practice, which, at present reached its highest elaboration in the great Polynesian South Sea, extended between Posterior Asia and the continents of America. And everywhere throughout these regions it was totemistic or mythological; and in India, and in Java, and others of the South Sea Islands, it had transparently suggested the ritualistic vestments that had taken its place for the use of those locally exercising the sacerdotal or sovereign authority. Nowhere is it found used merely for its attractiveness. In fact, in Burmah, women are frequently tattooed expressly to detract from their beauty. In the early ages of the Church Christian nuns were for this very reason similarly stigmatised. Branding is indeed a survival of ritualistic tattooing; as are also crests and coats-of-arms, as regards the objects borne. The ritualistic character of the dress, including the head-dress, shoes, and jewellery, of the Pharaohs, and the Chaldæan, Assyrian, and Babylonian kings is obvious and undeniable. Painting the body probably very widely marked the passage from tattooing to the use of vestments; and the extreme sanctity attaching to tattooing is proved by the practice of it subsisting, at least as a poetic figure among the Jews, long after it had been forbidden

* Tahaiti is a long cry from Egypt. Yet one cannot help wondering whether there is any historical connection between the Tahaitan, *tau-tau*, our word tattoo, and the Egyptian *tau* cross.

among them by law; by its continued prevalence in Mohammedan countries; and by such legends as that of the miraculous stigmatisation of St. Thomas of Assisi, St. Catherine of Siena, and other saints of the rival Franciscans and Dominicans. Sir George Birdwood, in conclusion, desired to repeat the expression of his deep sense of obligation to Professor Schulze for his most interesting and valuable paper, which was as full in detail as it was comprehensive in scope; and he hoped that the report of it in the *Journal* of the Society would be accompanied by reproductions of the samples of textile pattern designs exhibited by Professor Schulze, excepting those subsequent to the debasing period of the French Revolution, the evil influences of which catastrophe on every department of the industrial art of Europe had been felt to the present day.

Mr. THOMAS SNAPE, M.P. (Chairman of the Technical Instruction Committee of the Lancashire County Council), said that he desired first of all to join with Sir George Birdwood in his high appreciation of the paper. All developments of human progress were interesting, but a learned and lucid exposition of the growth of an art, which had such a wide application, was specially interesting to those who were connected with the great industries of the country. He had lately had the opportunity of meeting Professor Schultze at his own school at Crefeld, his visit being influenced by the same reasons which brought him there that evening, which was not merely to hear the history of the progress of art, in its application to textile fabrics, but to ascertain how far such information could be made useful to English manufacturers. In Lancashire and Cheshire was found nearly all that was left of the silk industry in England, though there were some remnants of it at Coventry and at Spitalfields; and even in Lancashire it was a decaying industry. It occurred to some connected with the Lancashire County Council that it was possible to revivify that industry if adequate technical instruction were given to the young people employed in the manufacture, and, as there was really no school in this country, he desired to see what was being done on the Continent, and how it was that they could develop the manufacture, and realise prosperity, while at home their manufacture was in a state of such depression. Schools of design, suited to such industries, scarcely existed at all, though there were classes at Macclesfield and, he believed, at Coventry, in connection with the silk manufacture, but the only institution which existed in England which would really answer the name was the technical school at Manchester. Even there, he was sorry to say, that, although the cotton weaving had a prominent place in the instruction, the silk industry had very little opportunity of being taught. It was not from any want of sympathy on the part of the conductors. When the new building, which would be of a palatial character, was constructed, he had no doubt a much larger impulse would be given to technical instruction, in connection with silk. He visited therefore the weaving schools at Zurich and Lyons, as well as at Crefeld, having with him a gentleman well versed in the subject, and they were both astonished beyond measure at the advance that was made in each of those countries, in connection with their weaving schools. In the cotton manufacture in England, there was some attempt now made to introduce textile designs; they were not very elaborate, but the Jacquard loom was now being brought into use to some extent; but, in silk, they were quite unable to compete in high class designs with the Continent. This was partly owing to the fact that, on the Continent, nearly all the best designs were produced, as might be expected, by the handloom, and owing to the length of hours and lowness of wages, it was not probable that England could be able to compete with the Continent in manufactures that had to be produced in that way. But now, in Germany and Switzerland especially, and also in France to some extent, he found that, even in very high-class designs, the hand-loom was being superseded by the power-loom. That being so, he thought it was quite possible for us in England, who had not been beaten in the application of steam power to manufactures, to regain some of our old *prestige* in the manufacture of silks, and the production of beautiful designs of a more modern character than those that had been shown on the screen, such as were worn by ladies at evening gatherings and at drawing-rooms. All these manufactures, at present, came from the Continent, but many of them they saw actually being made there by steam looms; and the ingenuity by which the careful and delicate manipulation of the hand was now copied by steam-power was astounding to those who had never seen it before. He had been deeply interested in this paper, because it had shown how art had grown from its infancy to its present proud position. But if this paper was to be of any real service beyond mere matter of passing interest to the art student, they must develop, along with the art teaching and design, a manual power of reproduction. In fact, he thought that should be the first stage, otherwise the best designs would be useless. In Lancashire they were now realising the urgent necessity of the application of art to manufactures. There were considerable developments of art in connection with some manufactures, but not much in textiles; for instance, nearly all the wall-papers of the country were produced in Lancashire, though most of the designs chiefly came from France. The same with the designs for calico printing, though these delicate and chaste designs were applied on a large manufacturing scale in Lancashire. Neither in France nor elsewhere could they surpass this country in the reproduction of designs on the surface, but for those designs they had to go abroad. He thought, therefore, there was considerable room for improvement in the design branch of art, but with regard to textile fabrics, they needed mechanical and technical teaching, as well as

artistic. They had been doing what they could in this direction. In Lancashire they had a larger sum to dispose of than any other county in England, except London, viz., £40,000 a year, and they were endeavouring as well as they could to apply it to technical teaching in connection with local industries. Amongst other things they had voted a sum of money to the silk industry, but the misfortune was that, though the money was ready, there was no one to receive it, because there was no institution which could utilise it. In some of the silk factories abroad they saw as many as 1,100, 1,200, and 1,300 hands, and the people there were thoroughly in earnest in giving to themselves the most solid and thorough education in connection with their manufactures. At the Martinière School at Lyons, a high grade school, he found a professor who gave a course of lectures on the technicality of silk weaving to the boys during one hour out of the hour and a half which was allowed for dinner. That class was very well attended, the boys being willing to deprive themselves of the play which they would otherwise have enjoyed, in order to listen to a clear though somewhat intricate lecture upon the composition and decomposition of designs connected with the silk industry. He wanted to see England wake up to the same spirit of enterprise which characterised their Continental neighbours, and not be content to go on under the old rule of thumb which had so long prevailed.

Mr. J. SPARKES said that the first thing which struck him in connection with this paper was the admirable way in which the lantern might be made use of for illustrating lectures on this and kindred subjects, and he thought this was a matter which might well be pressed on the attention of those who were now trying to do great things with the funds at their disposal, that were voted by the County Councils all over the country. These funds amounted at present in England to £750,000 a year, and when one considered that the whole amount the Science and Art Department had ever given, in direct aid to technical instruction, amounted to £150,000, it was quite obvious that an engine of enormous power was in the hands of the County Councils. So far as his limited means of observation went, he might say that they seemed to be experimenting in a way that it was not very delightful to observe. There was plenty of money, but an obvious want of intelligence to direct the application of that money to the demands of the country. Some of the crude efforts that were made to teach boys wood carving when they ought to be learning gardening appeared to him absolute waste of effort, but if these sporadic efforts now made were converted into a systematic organisation, by the aid of the enormous funds at the disposal of the County Councils, an impression would soon be made on many neglected or overlooked industries. The last speaker, in reference to the silk industry, appeared to him to somewhat underrate what was being done even under our limited science and art teaching. The original intention of the Government system was to give direct aid, in the way of technical teaching, to the manufactures all over the country, but when that was proposed the authorities were met with a distinct disclaimer from some of the leading manufacturers intended to be so benefited, and at Manchester they refused absolutely to have such classes. If the Government schools had not done what was expected of them, a great deal of the blame must rest with the manufacturers themselves. At the present day they had matters in their own hands. They had these enormous sums at their disposal, and it was for them to apply them to such industries as they wished to see improved. The Central School at South Kensington had no doubt been very limited in its efforts, but for all that, they turned out every year a certain number of very capable designers, who had the advantage of the run of the Museum, under the teaching of a capable master; but master or no master, an intelligent man who had the run of the South Kensington Museum must, at the end of two years, have gained something at any rate which he did not possess before. Those men might be seen in the Museum every hour of the day, and what was most astonishing was that, for every designer who came from an English country town, they would have more Danes, Germans, and Frenchmen, and, in fact, it appeared as if the great use of that Museum was to educate foreigners rather than ourselves. That was not the fault of the Science and Art Department; it rested with the manufacturers or designers in our own country. But in addition to the numbers educated in that way, there were large numbers who, without receiving any direct subsidy from the Government, came up relying on their own resources, perhaps, in some few instances, assisted by manufacturers, to study at South Kensington. He was told that at the present moment in Spitalfields, silk was being made as finely and as well as ever it was in this world. He was told further that, quality for quality, Spitalfields silk was cheaper as well as better than the French silk, and also that adulteration was going on in French silk to such an extent that, practically, the fabric did not consist of silk at all. He was not speaking from personal knowledge, but he thought it only right to mention the matter after the remarks of the last speaker.

Mr. HUGH STANNUS agreed with previous speakers as to the wide extent of the subject, which had necessitated so cursory a treatment. The chief authorities on the subject, to which an English student had access, were:—"die Geschichte der Textilkunst," by Fischbach, which had been re-published by Quaritch, with a very useful English translation of the text; and "l'Ornement des Tissus," by Dupont-Auberville; and a smaller work by Mr. S. Vacher gave some interesting late-mediæval and early renaissance patterns derived from pictures in

the National Gallery and elsewhere. Mr. Stannus was interested to observe how completely Professor Schulze agreed with the explanations of the storiation, as given in Fischbach; and he desired to express his thanks for the popular manner in which the subject had been brought before them.

Mr. LEWIS DAY said he had nothing to add to the very learned paper of Professor Schulze except his thanks; but his friend Mr. Sparkes had whispered to him that he ought to say something in reference to Mr. Snape's remarks on wall papers. Mr. Snape looked at the subject entirely from the Phillistine point of view. If it were true that manufacturers had to go to France for designs for wall papers, it was certainly not because Englishmen were not capable of producing good designs, but rather because certain tradesmen found it to their interest to introduce French styles to which some English designers at least would not condescend. One had only to look at the patterns chronologically arranged on the wall to see how, as they got round to the French period, the designs got worse and worse, until in the end they might best be described by a word for which he had to thank Mr. Snape—they had there, indeed, the "decomposition" of design. Leaving out of the question English designers of repute, he felt bound to say, speaking as an examiner at South Kensington, that there were annually sent in for national competition quite an appreciable number of designs which had in them more originality than anything that was being produced in France. Even at the last Paris Exhibition, where English decorative art was most inadequately represented, there was, in that little English show more *invention* in design than in the whole of the French section put together. The French seemed to have but one idea, that of reproducing their dear departed styles.

The CHAIRMAN said:—Speaking, as I do, as the representative of a National Association, which has for its one object nothing less than a complete renaissance of an almost defunct British artistic industry, namely, that of the manufacture and decoration of silk, it will be at once seen how pertinent is the subject now under discussion to such an industry. It is in relation to it that I will venture to make a few remarks; and if it be true that silk is to fabrics what gold is to metals and the diamond to precious stones, we may readily concede that too much importance cannot be attached to the cultivation of an artistic perception and treatment of a material so susceptible of being beautified as silk, by right thoughts about dyeing, by a refined power and skill in the arrangement and proportion of colouring, and then chiefly in making it the medium of pleasureable communicability to both artist and possessor in patterned devices deftly designed. Professor Schulze has made it easy for us to see, in his admirable paper to-night, two things: first that in all the earliest patternings there was both motive and meaning, and that the further we go back into the history of designing the deeper we find the motive, and the more important the meaning, generally, by symbolism or symbolic storiation—as Mr. Stannus would say—which, by escaping too materialistic a treatment, corresponds, in a measure, with that of the later conventionalising of floral and other subjects. In the conventional treatment and designing of foliage and flowers which characterises the patterns of the Italian Renaissance period, and which, in times still later, gradually parted with its conventionalism for the more pseudo-æstheticism and materialistic designing in France of the eighteenth century—notably, in the reign of Louis XVI., and more so since then the designs of patterns have lost much artistic force and control, and have descended, as a whole, to mere flower drawing. A new era, however, has opened in England, through the efforts of the pre-Raphaelite school; and in the decorative designing and production of patterns we see, in the able and artistic work of William Morris, a determination to hark back to truer principles and an abler perception of beauty of form and colour. This worthy example is now being followed in various crafts by a band of artistic enquirers; and the time, I feel sure, is approaching, if not actually arrived, when silk manufacturers need no longer be under the necessity of calling in the aid of either the designers of Paris or Lyons. For myself, I must confess, that I at present prefer the old patterns; they, like the old songs, are more imaginative, and appeal to me with greater meaning and motive than most of the modern designs do. If patterns must be designed to give continual pleasure they must be something more than a mere ringing of the changes in the disposition of foliage and flowers; they must be such as to attract constant notice by their meaning and so be such as one likes to live with. Patterning ought also to be something better than the relieving of surface from regularity and plainness. As a rule, at the present day, very few people actually look at the patterns they select for personal and domestic decoration, for the very reason that usually there is nothing in the pattern save the most dreary wall-papering common-place. I think such historical treatment of the subject as we have been favoured with to-night is calculated to set us thinking about retracing our steps in stimulating a desire in both the designer and user of patterns for more motive and for something more of meaning. The conventionalising of patterns seems to me to have culminated in the Renaissance when Italian brocades and velvets of fine design were contemporary with the great painters of the Tuscan and Venetian schools; from Andrea Orcagna in the middle of the 13th century, the period of the dawn of the Renaissance, to Michael Angelo and the middle of the 16th century. It is an interesting question, and one I have never seen decided, whether the great Italian painters were also designers

of patterns. In so many of their pictures we see their backgrounds, hangings, and dresses covered with contemporaneous or older patterning, but, as they generally hang in folds, the inference is perhaps justifiable that they were reproductions of the actual woven brocades or velvets, and represented the type of the craft-patterning of the time. In a picture by Andrea Orcagna of the coronation of the Virgin, of the date about 1370, the patterning of the dresses of the two principal figures suggests a Sicilian Saracenic motive and treatment, and is a century older than the picture. In the same picture there is a very good diaper pattern of typical Italian brocade designing forestalling the Renaissance. In a picture of Fra Angelicos, eighty years later, of Christ surrounded by angels and saints, there is on the robe of St. Gregory a design very much after the fashion of those of Louis XIII., of lopped branches symmetrically arranged, but more artistically disposed than in a later time. These Italian pictures of the Renaissance abound with patterned dresses and hangings, as may be seen in the National Gallery in London, and in the principal Continental galleries. This period had no doubt its artistic designers other than painters, for Professor Schulze has shown us what great encouragement was given to the silk manufacture of Italy by the Government in those days—an encouragement commensurate with the vast importance to their country of such an industry, and one which is now seeing its second renaissance there successfully rivalling the able products of the looms of Lyons. But, although Italy might have depended more for its Renaissance silk designs upon designers of the craft, than upon painters, we know in how many instances painters and architects have excelled, and do still excel, in the decorative treatment of patterned work, and I believe such influence and work can be traced in the designs of some of the Italian painters' pictures. Take Carlo Crevelli as an example. He painted in the middle and latter part of the 15th century. In his pictures you see elaborate designs of brocaded silk, indicative and typical of the conventional Venetian brocades and velvets of that time. The patterns he painted are all different in design, but there is a sameness and individuality of diaper treatment which makes me incline to the opinion that he was also a pattern-designer for the Italian weavers of those days. The patterns in the pictures of Fra Angelico and Paulo Veronese are worth studying, being suggestive of earlier patterning treatment, as well as of influences which operated for centuries later. Ireland has been famous for patterned work from very early days. The celebrated Book of Kells abounds with most intricate and elaborate ornamentation executed so long ago as the 7th century. Before the year 900, Ireland had over 60 remarkable scribes whose names are still preserved, and as their occupation was in writing books and not in printing them, no doubt the designing of book-pictures, borders, and initial letters formed no little portion of their pleasurable duty, and in that way the development of decorative designs may, and must have been owing to the genius of the monastic scribes of the Middle Ages, in their lavish and exquisite decorative treatment of missals and other devotional books, before the era of the printing press. This Book of Kells, a book designed and written for the Church of Kells, abounds with symbolic serpents, a treatment which singularly re-appeared in almost all the 17th century domestic oak carving throughout England. I do not think we know as much as we ought of the fancy and motive for this reptile renaissance at so comparatively late a period. Christian symbolism is often repeated in the Book of Kells by the vine and trefoil. It may be well to recapitulate the various kinds of silks, chiefly patterned, with which history acquaints us:—

Holosericum, or all-silk cloth for classic tunics.

Subericum, the woof of which was silk, and the warp of another kind of fibre.

Samit, from Examitum, a rich and costly silk of the 13th and 14th centuries, much used for vestments, the warp of which consisted of six threads.

Cyclatoun, a fine light and thin silk.

> "In a robe right ryall of a red cyclatoun
> With beastes and byrdes wrought."

Cendal, sandal:—"Hugh Pudsey left two silk Albs to Durham, made of cendal."

Syndonus, a better kind of cendal.

Baudekin, from Baldak, or Bagdad, a mediæval altar-hanging. The dyers of Bagdad were famous for dyeing a fast crimson. Anthony Corsi made an embroidered Baudekin for State purposes for Henry VII., 47½ yards at £11 a yard, £522 10s. 0d.

Taffeta, a silk for linings.

> "Lined with taffeta and cendal."—CHAUCER.

Sarcenet (*saracenium*).—The makers were the Saracens of South Spain. In the 15th century York Cathedral had silk curtains of this stuff.

Satin, from *acetyn* originally, then *setani*, which gradually became corrupted into satin.

> "Cloths of gold and satins rich in hewe."—CHAUCER.

Cadas, or *carda*, an ancient spun-silk made of the outer and unreelable fibres of cocoons.

Camoca, a fabric made of camel's hair and silk for clothing and the hanging of State beds.

> "In kyrtle of cammaka am I clad."
> "Coventry Mysteries."

Cloth of Tars, the forerunner of Cashmere.

Velvet (*veluto*).—It is uncertain where this pile-fabric originated, but, I believe, it first saw light in Persia. Of all the velvets, that of Gregoire, a Lyons weaver of the last century, is the most artistic and remarkable. He wove portraiture and subjects of great delicacy of treatment. Excellent specimens are to be seen in the Musée de la Bourse at Lyons. They are highly prized, and are now very costly.

Fustian.—A Byzantine silk fustian chasuble is recorded.

Diaper was a one-coloured patterned silk, showing two effects as in linen.

There were other silks of an older period, such as *stauracina*, patterned with acorns or gammadia; *de fundata*, a netted pattern, from *funda*, a fisherman's net; *strangulata*, striped or barred silks (one is at Exeter, of the date 1277); *imperial*, a Grecian silk of the 12th century, with marble and lions woven in gold; *cloth of pall*, a gorgeous clothing of blue and crimson or shot. Further information respecting ancient silks, and illustrations are furnished by the works of Dr. Bock. Amongst the more modern names of silks, chiefly patterned, are the following:—Armure: a. grain précieuse, a. lozenge, a. royale, a. Choiseul, a. régence, a. cannelé, a. Pekin façonné, a. régence façonné, a. chevronée, a. merveille, a. royale damassé; Pekin satin: p. reps, p. façonné pompadour, p. satin cannelé, p. armure damassé, damassé velours non coupé, p. armure satin and velvet; satin: s. damassé, s. raye broché, s. Pekin cachemire, s. broché ombré; satinette; crêpe, c. frisé, c. de chine, c. de chine broché; gaze plumetis, g. bayadère, g. Pekin reps; velvets, velours broché; poplin, p. broché; taffetas port broché; bengaline; grenadine, g. broché, g. broché Pekin moire, g. Almée, g. broché lamée, g. Pekin broché; brocade; brocatelle, b. ecaille; cotelé, c. Pekin satin, c. Pekin satin broché; cachemire; foulard, f. sergé, f. broché, f. imprimé; faille; gros-grain, g.g. damassé; moire, moire Pekin satin, moire Pekin rep; granité rayeure taffeta; nebuleuse; organdy soie plumetis; peau de crocodille; plush; ombré; arc de ciel; serge; s. rayé, s. broché, surah; s. damassé Pekin chevron; tussur; t. rayé; damasquiné; granité; lampas; matelassé; and many others, each season seeing newer styles and developments. Professor Schulze has shown us what has been done in the patterning of silk in past ages, and how much meaning and pattern-design there is in the woollen, linen, and silken fabrics of Coptic Egypt. We know that the Egyptians were famous artificers from the earliest times. We read in the 10th chapter of the 1st book of Kings that Solomon had horses brought out of Egypt and linen yarn, and that the king's merchants received the linen yarn at a price, and where mention is made of "tapestry and striped linen in Egypt," it is said by scholars that it should read, "with striped *cloths* of the yarn of Egypt." In support of this rendering I have brought a remnant of striped Egyptian cloth of silk brought by my friend Mr. Flinders Petrie, from a Christian Coptic tomb at Fayoom, of the 6th century. It is a very interesting specimen of weaving and dyeing. The colours are a rich, deep, and most permanent crimson, two shades of olive green, and one of gold. I have had an exact fac-simile reproduction of it made. The dyes are the same as the original, as far as by chemical analysis I can determine, and the stripes and peculiar herring-bone weaving are exactly like the original. It is said that plaids, which are crossed stripes, were originated by the Gauls. It is recorded that the tunic of Boadicea was a plaid pattern. I found veritable tartans being woven at Peshawur for the neighbouring hill-tribes. In my opinion the artistic patterning of silk stuffs culminated in Italy at the end of the 15th century, and ever since that time there has been a decadence in the power of decorative design, and a more meaningless and materialistic treatment, but a greater development and variety of colouring effects. The Genoese fabrics, chiefly stuffs of velvet and velvet frisé of the 15th century are marvels of beautiful designing. As we are now near the revival of the British and, I hope, the Irish silk industry, let me call the attention of designers present to-night to this opportunity for the production of designs more worthy of the name than the meaningless and commonplace patterns which have generally so long characterised English silks, and caused our Continental silk neighbours to strip us of our industry and gradually to attract to themselves a business turnover, which now amounts to a million pounds sterling in every month that passes by. If designs of a sufficiently attractive and artistic character cannot at once be evolved, we shall have to hark back to the best of those of earlier times, until the material and its possibilities are better understood by our designers. The Italians of to-day are very successfully reproducing their own Renaissance patterns, and their manufacturing trade is rapidly increasing, especially for export business. As the object of the Society of Arts is to direct its teachings into the channels of utility, I make no apology, in my capacity of President of the Silk Association, for emphasising the subject of pattern-designing and colouring in their relation to the decoration of silk, more especially as Professor Schulze, in addressing us this evening, represents the art and design-side of a German town, now of great importance as an extensive silk-manufacturing centre, whose Royal Weaving School, with its important Textile Museum, are offering silent lessons to us in what may be done in the teaching of drawing, the encouragement of design, and in technical instruction. It is greatly to our industrial loss that we are so far behind Germany and France in these respects, and that all our silk centres are still without collections of patterned silks of all times and places. I am told by Professor Schulze that the Crefeld Collection, although always open to students, is only accessible to the public nine hours per week; yet it is visited by 6,000 people annually, who chiefly come in the interests of silk manufacturing to study ancient examples. The recent visit of H.R.H. Princess Mary and Princess May to Spitalfields to see the silk-weaving there, the Silk Exhibition, held in London some time ago by the late Lady Egerton of Tatton, have shown the practical interest taken by Royalty and the leading ladies of the country in the British silk

industry, and a splendid opportunity is now given to the designers and manufacturers to prepare for a Silk Exhibition next year, and to show that our native art and skill can keep pace with the best products of foreign looms, in beauty of design, variety of pattern, colour, and price.

Professor SCHULZE briefly acknowledged the vote of thanks, and the proceedings terminated.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 19, 1893; ALEXANDER SIEMENS in the chair.

The following candidates were proposed for election as members of the Society:—

Cole, Robert Langton, 2 Shorter's-court, Throgmorton-street, E.C.
Wrigley, Norman, 10, Brunswick-gardens, Campden-hill, W.

The following candidates were balloted for and duly elected members of the Society:—

Cuff, J. Clement, Singapore.
Horn, Thomas L., Fernbank, Little Heath, Old Charlton, Kent.
Mackintosh, Donald James, M.B., Western Infirmary, Glasgow.
Monk, J. Henry, 5, Buckingham-gate, S.W.
Newitt, William Thomas, Post and Telegraph-offices, Madras.
Nursey, Perry F., 161, Fleet-street, E.C.
Schmidt, Frederick Thomas, 9, Clarendon-street, Bradford.
Smith, Watson, 34, Upper-park-road, Haverstock-hill, N.W.
Tyler, Captain Henry Edward, R.E., 11, Craigorne-road, Blackheath, S.E.

The paper read was—

SOME ECONOMIC POINTS IN CONNECTION WITH ELECTRICITY SUPPLY.

By GISBERT KAPP.

It is now about ten years since electric lighting by means of glow-lamps has come within the reach of the average well-to-do householder. Those who were the first to avail themselves of the new illuminant did so because they recognised its advantages and comforts, but the question of cost, and especially of working expenses, was in those days a secondary consideration.

It is true that ten years ago, as now, a man who thought of having his house wired, and machinery installed for lighting, would begin by making inquiries as to what the installation would cost, and would perhaps invite estimates from various electric light firms, with a view of placing the order with the firm who submitted the lowest tender; but, beyond counting his first capital outlay, the question what the light would cost him year after year was either not considered at all, or, if considered, could not be settled beforehand, because at that time there was no practical experience regarding the various items of expenditure which make up what we now understand by the term "annual working cost."

The heavy initial outlay for generating-machinery tended at first to retard electric lighting, but when, after a few years, central stations began to be erected, and householders could have current laid on in the same way as gas and water are laid on, the use of electric light developed with great rapidity. It would have developed still faster were it not for the initial outlay in wiring and fittings, which is still considerable. A householder who does not own his house, is naturally reluctant to lay out for wires and fittings a sum amounting to from 20s. to 50s. or 60s. per lamp, because he has no certainty that, in the event of his leaving the house, the next tenant would take these things over; but the difficuty is not nearly as serious as in the case of generating machinery, the outlay for which is much greater. It is also, as a rule, possible to make some arrangement with the landlord, under which the latter pays part of the cost for wiring, the outgoing tenant being at liberty to take the fittings with him, if the incoming tenant refuses to take them over.

The establishment of central stations has, therefore, resulted in a great development of private electric lighting. It has, however, done more; it has led to a true appreciation of the cost of electric lighting. The householder knows what he spent on wiring and fittings, he knows what he has to write off annually to cover any possible loss in case he leaves the house, he knows what he pays for lamp renewals, and he knows, by his meter, what he has to pay for current. He can thus ascertain what each lamp installed costs him per annum, and those who take the trouble to keep accurate accounts generally find that the light is not nearly so expensive as they had at first supposed. In other words, the electric light, which, ten years ago, was an expensive luxury, has, thanks to the establishment of central stations, now become a commodity

obtainable a ta moderate price, and, moreover, at a price which can be accurately ascertained beforehand.

The cost of current is, as you know, fixed by the Order under which the electric light company carry on their business, and it is a remarkable fact that most companies charge less than they are entitled to charge under their order. The present tendency of electric supply companies all over the country is to reduce their rates, and this shows that they possess no monopoly, even within the limits sanctioned by Act of Parliament. Some years ago there was an apprehension that the supply of electricity, like that of gas or water, might in time grow up to be a gigantic monopoly, but such a fear is groundless. Gas and water are commodities that, generally speaking, cannot be produced privately and on a small scale. A householder in town cannot erect on his own premises a water works or a gas works, but he can easily put down his own electric light works, and thus make himself independent of the electric light company. Whether it will pay him to do so will depend principally on the amount of current he uses. A small user will find it very expensive, and a large user fairly cheap. The former could, therefore, afford to pay the maximum charge per Board of Trade unit which the Act permits, and be still better off than if he employed his own generating plant; but the latter will be able to generate his own electricity cheaper than that, and if the company desire his custom, they must supply him at a rate not much higher than the rate at which he could supply himself. Under these circumstances, the company might wish to make a difference in their charges, according to the class of customer served. But this it cannot do. The legislature has very wisely inserted a clause in the Act, compelling the supply company to charge all its customers precisely in the same way. The effect of this clause is that, in so far as the competition of a private generating plant may influence the charge, this influence is exerted by the large, and not by the small, consumer. In other words, the large consumer protects the small consumer against any attempt on the part of the supply company to take an unfair advantage of their monopoly, even were the company so minded.

There exists, however, a far more general check against any monopolist tendencies in electric supply, and that is the fact that a cheap tariff means a large business, and that profit can only be made by an electric light company if its business is large. I have pointed out already, that, where the supply is derived from a central station, the cost of electric lighting can be ascertained with great accuracy. With private installations this is not so easy, and is, in fact, very seldom done.

A person who wishes to introduce the electric light into his house, when the latter is not within reach of the mains of a supply company, invites tenders for generating plant from various contracting firms, and places the order with the firm that sends in the lowest tender, or, if the difference is not very great, with the firm that has shown him the prettiest fittings, or is recommended by some friend who has had his house lighted by the same firm. The number, candle power, and disposition of lamps, and the arrangement of machinery are left to the contractors, who, having done similar work before, are naturally supposed to know exactly what is wanted. They do know what is wanted, but they also know that several other firms are competing for the same work, and that a low quotation is likely to secure the order.

The principle on which tenders are invited is not to so design the installation that the requisite amount of light will be obtained at a minimum annual working cost, but at a minimum of capital outlay.

Once the plant is put down and satisfactorily started, the contractor has done his part of the work, and it is henceforth the owner's look out to run the installation. Any faults of design, tending to increase the working cost, constitute a continual source of loss, and if the money thus annually wasted be capitalised, it will generally be found to exceed the sum which, in the first instance, would have had to be expended in order to avoid these faults.

This economic principle has, of course, been fully recognised, and followed by those engineers who have to design central stations, but it is generally disregarded by the contractors for private installations, who are forced by competition to aim rather at low first cost than economy in the long run.

It might, perhaps, be thought that, in such a matter as a private installation, there is no scope for the combination of engineering and financial skill required to produce the best economic results in central station work. Indeed, many electric light contractors have their designs cut and dried beforehand. An installation of so many lamps requires a gas-engine of a certain horse-power, a dynamo of a certain output, and a battery of a certain

capacity. They know all this from previous experience, and see no reason for making any change, and the same plant is put down regardless of the special conditions in each case. I need hardly say that local condition should be very carefully taken into account when designing an installation, either large or small; and although I cannot attempt, in the short time at my disposal, to treat this subject at all exhaustively, I will endeavour to direct your attention to a few points which influence the economic working of the installation.

Time of Lighting.

If you ask the manufacturers of glow lamps at what voltage their lamps should be worked, they will tell you at the voltage for which the lamps are made. The lamps will then last from 1,000 to 1,500 hours. Yet it may be advantageous to run the lamps at a higher voltage. To put the case in as simple a way as possible, I will assume that we have to do with two country houses, each requiring a total of 100-16 candle-power lamp installed. Let the driving power be gas in both cases, and at the same price; but assume that one house is inhabited all the year round, and that each lamp is used for 500 hours annually. The other is inhabited only for a few months, and each lamp is used for 100 hours in the year. Let, further, the maximum number of lamps burning simultaneously be in each case such as to give an aggregate of 1,000 candle-power. If we work the lamps in the first house at $4\frac{1}{3}$ watts per candle, we shall require a battery capable of giving an output of 4 to 5 kilowatts, and a gas engine and dynamo to correspond. Each lamp will require renewal once in two years. Taking the lamps at 3s. 6d. each, the annual cost of lamp renewals would be under £9, whilst the interest and sinking fund in the generating plant, taken at 8 per cent., would amount to about £60, and the cost of current, which we may roughly take at 6d. per unit, would amount to £87; total £156.

The same plant, worked in the same way, could, of course, also be used in the other house. The lamp renewals would be only £2, the interest would remain the same, but the cost per unit would be slightly increased, because the items for repairs and labour would not be diminished proportionately to the output. Assuming an advance of 2d. per unit on this account, the expenditure would be as ollows:—Interest and lamp renewals, £62; cost of current, £23; total, £85. This, however, would not be the most economical way of lighting the house. We would do better to overrun the lamps, because then the same amount of light could be obtained with a smaller plant. Say we run the lamps at a higher voltage than fixed by the makers, so as to obtain a candle with 3 watts. The total power now required is a little over 3 kilowatts, and the cost of generating plant, instead of being £750 as formerly, would be reduced to about £550. The cost of repairs would be slightly less, but against this saving we may set off the fact that the smaller engine will use rather more gas per horse-power. The cost of labour will, of course, remain the same as before, so that we shall again have to reckon the current at 8d. per unit. But instead of using 700 units, we shall now only use 480 units, at a total cost of £16. The only item which has been increased is the lamp renewals. The higher we work the lamps the shorter will be their life, and the higher will be the lamp bill. To take an extreme case, let us assume that the lamps either break or become so blackened as to be unfit for use after half the time, as in the other case. The renewal bill will then increase from £2 to £4, and the total cost of lighting works out as follows:—

8 per cent. interest and sinking fund on £550	£44
Current	16
Lamp renewals	4
	£64

a saving of £21 per annum, due to the fact that we are working the lamps at a voltage higher than that recommended by the makers. In this calculation of annual cost I have left out the item for interest and sinking fund on wiring and fittings, as this is not effected by the change in voltage.

Cost of Power.

Another item which requires very careful consideration is the cost of power. When water-power is available, and hydraulic works have to be erected specially for lighting purposes, we should naturally try to do with as little power as possible, so as to reduce capital outlay and maintenance of hydraulic works. But small power means a long daily charging period, and consequently a heavier labour bill than would be incurred were the plant sufficiently powerful to restrict the charging time to one or two days per week. The best design

must obviously be a compromise between these conflicting conditions.

If the power is derived from steam, gas, or oil, the cost of fuel is of material importance in designing the plant. Let us suppose that gas is the motive power, and let us again compare two houses, each requiring 100-16 candle-power lamps, the lighting time to be the same in both houses, but the price of gas in one case to be 2s., and in the other 4s., per 1,000 cubic feet. In the house supplied with cheap gas, we work the lamps at $4\frac{1}{3}$ watts per candle, and consume annually 3,500 units. For a small installation, worked with cheap labour and indifferent supervision, we cannot hope to do better than about 80 cubic feet of gas per unit delivered to the lamps. This brings the bill for gas and lamp renewals to £37. If the same plant be installed in the house where gas costs 4s., and worked in the same way, the corresponding item would amount to £65. Suppose, however, we work the lamps at 3 watts per candle, then we should only consume 2,400 units, and a smaller plant would suffice. The smaller engine would use about 90 cubic feet per unit, making the gas bill £43. The renewal of lamps would now cost twice as much as before, namely, £18, bringing the cost of these two items to £61, or slightly less than when the lamps are worked at their normal voltage. This calculation is based on the price of 3s. 6d. per lamp. There is, however, good reason to anticipate a large reduction in the price of lamps after the lapse of the Edison patent, and the lower the price of lamps the greater is the economic advantage in over-running the lamps. This is a point which contractors for private installations would do well to consider. With lamps at 1s. 6d. each, it would pay to run at something like $2\frac{1}{2}$ watts per candle, and this would mean a reduction of about one-third in the capital outlay for generating plant, and a material reduction in working expenses.

I should, however, point out that other considerations than wet have an influence on the working pressure. If we increase the pressure too much the light loses its soft mellow tint, and becomes disagreeable to the eyes.

Capacity of Plant.

In private installations worked by gas engines, the cost of gas is generally found to be the heaviest item amongst the list of engine-room expenses, and, in this connection, it is instructive to notice the difference between the theoretical and actual performances of the engine. Gas-engine makers are always telling us that a brake horse-power hour can be obtained with something like 30 cubic feet in small, and 20 cubic feet in large engines; and, as a matter of fact, these results are obtained on a full-load test. With a dynamo of 85 per cent. efficiency, and an engine consuming 30 cubic feet per brake horse-power hour, we should obtain the unit at the dynamo terminals for 47 cubic feet, and from the battery, for 67 cubic feet, assuming the battery to have 70 per cent. efficiency.

These results are, however, not actually obtained in small installations. The reason is that the gas-engine is, as a rule, worked much below its power, or, in other words, that the battery is too small. Since batteries are expensive items, costing between £40 and £50 per kilowatt output, it is natural to cut down the battery power to the lowest possible limit, but it is not true economy. A small battery means not only lower efficiency of the battery itself, but more maintenance, longer running hours for the engine at small loads, and consequently waste of gas. The cost of attendance is, of course also increased.

Power and Capacity of Battery.

In a private installation for domestic purposes, a storage battery is an absolute necessity. The owner of such an installation naturally expects to get the light at any hour of the day or night, and this requires some system of storage. The question is, how much storage? If the battery is small, the interest on capital outlay on account of the battery will also be small, and to this extent the working cost will be reduced. But, on the other hand, we must remember that a small battery is liable to be overworked, and will then deteriorate more rapidly, so that the cost of maintenance will be increased. It will also require more frequent charging, thereby bringing up the cost of labour. A further disadvantage is that, as already pointed out, the engine, when charging, will be worked much below its power, and therefore with low efficiency. All these defects are materially reduced if we instal a large battery; but in doing so we increase that part of the working cost which is due to interest on capital outlay, and it is obvious that before deciding on the best size of battery (as defined by its power and capacity), we must take very careful account of the local conditions in each particular case, such as cost of fuel, lighting hours, cost of labour, proportion of lamps lighted to lamps fixed, &c.

COST OF ELECTRIC SUPPLY

Owner of Installation.	Equivalent Number of 35 Watt Lamps Fixed.	Capacity of Generating Plant in K.W.	Maximum Load observed in K.W.	Total Number of B.T.U. used per Year.	Number of B.T.U. used per 35 Watt Lamp.	Load Factor per Cent.	Plant.		
							Number of Engines.	Number of Dynamos.	Sets of Batteries.
General Post Office, London	7,500	250	190	660,473	88	39·7	5 steam	5	none
G.P.O. Savings Bank Department	2,400	100	50	118,427	49·5	22·6	2 steam	2	none
Madame Tussaud and Co., Ltd., London .	1,090	40	32	72,224	66·3	25·8	2 gas	2	3
Messrs. Bainbridge & Co., Newcastle-on-Tyne	1,300	50	45·6	50,850	39·1	12·7	3 gas	3	none
Constitutional Club, London	1,600	100	45	116,900	73·2	29·6	3 steam	3	none
Arts Club, London ..	248	5·5	4·8	10,800	43·5	25·6	1 gas	1	1
Duke of Fife, London.	720	17·5	10·6	3,600	5·0	3·87	1 gas	1	1
Sir David Salomons, Tunbridge Wells ..	300	—	7·0	4,390	14·6	7·1	2 gas	several	3
Mr. C. W. Mitchell, Newcastle on-Tyne*	480	17	13	4,720	9·82	4·15	1 gas	2	1
Mr. W. H. Preece, Wimbledon	70	2	2	1,120	16	6·4	1 gas	1	1
Mr. S. E. Phillips. Blackheath........	74	3	2·2	1,448	19·6	7·5	1 gas	1	1

+ The figures are based on estimates given by the owner, the installation is now supplied by the Newcastle-on-Tyne Electric Lighting Company.

Generally speaking, if the domestic installation is very large, the capacity of the battery should be comparatively small, and its power moderately large. We would, in such a case, employ a battery of small size, but capable of giving a rapid discharge. In small domestic installations the battery should have a comparatively large capacity, and we would employ a kind of cell which is less liable to deterioration when left charged for long periods. In private installations for business purposes, the amount of light required outside of business houses is very trifling, and the battery may, therefore, be small. We would then arrange the installation to do nearly the whole of the lighting direct from the dynamos, and use the battery merely to steady the voltage, and as a limited reserve in case of breakdown of machinery. The necessity of running daily will of course increase the wages bill, but as the total amount of light required is large, an extra pound or two per week for wages does not materially increase the working cost per unit. In certain cases it will even be advantageous to work without a battery, and to provide against a break down by splitting up the generating plant into two or more units of suitable size.

LOAD FACTOR.

I have, in the foregoing remarks, briefly alluded to some of the features in private installations which affect the working cost, and have attempted to show that each installation, in order to work economically, must be designed with due regard to its special requirements. To use the same type of plant, and work it in the same way in every case, would be bad engineering, in the same way as it would be bad engineering to apply the same system of central-station supply to every town or district, regardless of the special and local conditions in each case. By careful attention to the special requirements, we can

IN PRIVATE INSTALLATIONS.

Cost per B.T.U. in Pence. Coal or Gas.	Stores.	Repairs.	Wages and Superintendance.	Water.	8 per cent. on Cost of Plant for Interest and Depreciation.	Total Cost for Generation.	Lamp Renewals.	Lbs. of Coal used per Unit in Lamps.	Cubic Feet of Gas per B.T.U. Generated.	Cubic Feet of Gas per B.T.U. Used in Lamps.	Price of Gas per 1,000 Cubic Feet.	Premises Lighted.
·623	·601		·863	·0378	·35	2·475	—	5·8	—	—	—	Government Buildings.
·948	·295		1·413	·122	·65	3·428	—	8·85	—	—	—	Government Buildings.
1·28	·235	·705	·6	—	·58	3·40	·283*	—	37	39	2s. 9d.	Exhibition.
·80	·038	·066	·390	·071	·49	1·855	·182	—	40·5	40·5	1s. 7¾d.	Shops & Workrooms.
—	—	—	—	—	—	—	—	—	—	—	—	Club.
2·66	·233	·111	·80	—	·922	4·726	·300	—	—	80·7	2s. 9d.	Club.
1·45	·5	·133	5·000	—	4·52	11·603	—	—	—	—	2s. 9d.	Private House.
3·22	·09	5·62 †	2·27	—	6·8	18·00	·103	—	—	85	3s. 2d.	Private House.
2·14	2·19		2·04	—	4·04	10·41	—	—	—	97	1s. 7¾d.	Private House.
7·38	·79	·95	2·22	—	7·1	18·44	1·28	—	--	144	4s. 3d.	Private House.
3·4	·16	—	2·58	—	5·8	11·94	·745	—	73·5	113	2s. 6d.	Private House.

* Including carbons for arc lamps.

† Including an estimated annual cost of £100 for renewal of batteries.

then bring down the working cost per unit to a minimum, but whether this minimum be high or low will depend on a circumstance which is beyond our control, and this is the extent to which the plant is used. It is evident that the more steadily and continuously any given plant be used, the greater must be the economy in working; or, to put it in another way, the smaller will be the cost per unit supplied to the lamps. Mr. Crompton has introduced the term "load-factor" to express generally the extent to which central-station plant is usefully employed, and the term may be defined more precisely in various ways. I shall here use it for private installations, in the sense of expressing the ratio of the actual yearly supply to the lamps, to the supply which would be required if the maximum number of lamps alight simultaneously at any time were kept alight over one year. To make this definition quite clear, let me take an example. Assume that, in a country house wired for 100-16 candle-power lamps, the maximum number ever alight simultaneously is 70, with an observed output from the generating plant of 5 kilowatts. If the plant were kept working day and night at this rate for one year, the total supply to the lamps would amount, in round numbers, to 44,000 units. Suppose you put a meter into the supply circuit, and that meter registers actually only 3,500 units in one year, then the load-factor of the installation would be $100 \frac{3{,}500}{44{,}000} = 8$ per cent. The influence of the load-factor on the working cost per unit is very great, as you will see from the examples of private installations, which I shall cite presently. The load-factor is, however, not under the control of the engineer who designs the installation; it is fixed beforehand by local conditions, and for this reason it is all the more important that these local conditions should be taken very

carefully into account in deciding the various points to which I have already referred, so that the owner may get the required amount of light for a minimum of annual expenditure.

Use of Meters.

Private installations are generally supplied with the necessary instruments to indicate current and pressure, but the cases where an electricity meter is used are extremely rare. A meter of this kind is, from the contractor's point of view, not necessary for running an installation, and will, under a competitive system of tendering, not be supplied unless the owner is willing to pay for it as an extra. From the owner's point of view a meter is, however, exceedingly useful, as it enables him to detect waste and keep the engine man and his machinery up to the mark. There is something illogical in the way most private installations are worked. The owner knows, or at least has the means of knowing, how much fuel and stores he uses, but he is entirely in the dark as to how much electricity he gets in return. It is as though a merchant kept only one side of his ledger posted up. If a meter is installed, and its readings are frequently compared with the amount of fuel used, the owner will be in a position to determine by actual experience the most economical way to work his installation, and he will be able to detect it at once if his engine, or dynamo, or battery begins to get out of order. Where a battery is used, there should be two meters employed, one measuring the whole of the supply coming from the dynamo, and the other the whole of the supply given to the lamps. The cost of the two meters is so trifling in comparison with the saving in working expenses, that no installation should now-a-days be put up without meters.

Examples.

By the kindness of various electric light contractors, and owners of private installations, I am able to place before you the actual working cost of such installations. The list is not as complete as might be wished, but it is difficult to obtain information of this kind, for the reasons already stated, namely, that the use of meters is generally considered a superfluous luxury. In a few cases meters were not used, but the output was regularly booked from time to time, and the total ascertained by summation. The results are given in the table (pp. 568-9), and to prevent misunderstandings a few words of explanation are necessary.

The total capacity of the installations is given in 35 watt lamps. There are, of course, in many cases glow lamps of a different power, and in some cases also are lamps installed; but, as it was necessary to bring all the installations to a common standard, I have selected the 35 watt lamp as the unit, and the number in the first column has been calculated by dividing by 35 the number of watts required collectively by all the lamps actually installed. In the column headed capacity of generating plant is given the output in kilowatts, represented by all the engines and dynamos installed, irrespective of batteries. The next column gives the maximum observed load and the ratio between this and the total generating capacity shows to what extent the machinery installed is really required. When the ratio approaches unity, the amount of reserve plant approaches zero, and this in an important installation is not desirable, although in a small private installation the necessity of having reserve machinery to guard against a break down is not so great. On the other hand, if the ratio is too low, that is to say, if we put in a great deal more generating plant than is actually required, we burden the installation with a uselessly large annual outlay for interest and sinking fund. The total units supplied during the year are in most cases actually metered, in some cases they are compiled from the entries at regular intervals of current and pressure in the log book of the installation, and in one case they are deduced from the statement of the owner as to the average number of lamps alight and time of burning.

The annual working cost is made up of the actual expenditure for the following items:—Fuel, oil, waste, and petty stores, given under "stores," wages and supervision, repairs, water, and a charge of 8 per cent. for interest and sinking fund on the cost of the generating plant. No account is taken of the cost of wiring, or fittings and lamps, because these items would be equally required were the current obtained from a supply company, and my object was to get a fair basis for comparing the cost of electricity made on the premises with that of electricity supplied from a central station. The result of this comparison is, roughly speaking, this. Electricity made at home for domestic purposes costs about twice as much as electricity supplied from a central station, but if made at home for business purposes its cost

only about half as much. A few remarks on the more important installations given in the table may be useful.

General Post-office.—I am obliged to Mr. Preece and Mr. Probert for the following figures, referring to the installations at St. Martin's-le-Grand and at the Savings Bank. At the former there are five, and at the latter two steam dynamos of 50 kilowatt output; no batteries are used in either case. The cost of stores includes not only all engine-room stores, but also renewal of lamps, wiring, fittings and all repairs. In the general table I have deducted ·3d. on account of lamps and fittings, but here I give the figures as given me by Mr. Probert—

	St. Martin-le-Grand.		Savings Bank.
Number of 16-candle-power lamps installed..........	3,750	..	1,200
Units....................	660,473	..	118,72-
Cost of fuel per unit	·623	..	·948
" stores "	·901	..	·595
" labour "	·863	..	1·413
" water "	·0378	..	·122
Total per unit	2·4243	..	3·078

The amount of coal burned per unit is in the two cases repectively 5·80 and 8·85 lbs. You will see from these figures that the Post-office, by using home-made electricity, obtain their light at less than half of what it would cost them if they obtained the supply from a company.

Madame Tussaud and Son, Limited.—In this case the motive power is gas and batteries are used to a limited extent The capital outlay for machinery and wiring is a little higher than would be the case in an ordinary business installation, and this is mainly due to the extra precautions taken against accidental extinction of lights. Each room in the exhibition is lighted from three independent circuits, two being main circuits, and the third a panic circuit worked from an independent battery. The switches are so arranged that a failure of either or both engines, or both main batteries, does not effect the panic lights. In designing the installation I adopted this arrangement because the effect of a panic in a place frequented by Bank Holiday crowds would be very serious. On the other hand, this and other precautions increased the capital outlay, so that the item for interest and sinking fund in the annual working expenses is larger than would be the case in an ordinary business installation, where such elaborate provisions for the public safety need not be made. The total cost of the installation was in round figures £4,000, of which £2,100, or about £42 per kilowatt capacity, was expended on generating plant. Towards the end of 1891, that is after the installation had been at work for over a year, I was asked by the directors of the company to generally superintend the lighting, and the installation has since then been under my charge. By the kindness of the directors I am able to give you the exact working cost for the year 1892, which for a total supply of 72,224 units to the lamps was as follows:—

	£	s.	d.
Gas (2,817,000 cubic ft., at 2s. 9d.)..	387	6	6
Engine stores	66	5	3
Repairs	141	15	0
Dynamo stores	5	2	6
Battery renewals	70	19	1
Wages and superintendence	179	0	0
8 per cent. interest and sinking fund.	168	0	0
Total	£1,018	8	9

The amount for wages and superintendence actually paid amounted to £279, but as this figure includes alterations of lamps, and putting up of new lamps, of which about 50 are added every year, I have deducted £100 on this account.

The item for engine repairs is exceptional. On being consulted about the installation, I found it necessary to have the engines thoroughly overhauled; but this expense will, of course, not have to be incurred every year. The plant is now in charge of a very efficient attendant, so that the repair bill for this year will be materially reduced. The best record of gas consumption in winter is 33 cubit feet per unit generated, and the average record over the whole year is 37 cubic feet per unit generated, and 39 cubic feet per unit supplied to the lamps. The total working cost amounts to 3·4 per unit supplied to the lamps, being about half what the supply from a central station would cost.

The total annual cost for lighting, including lamp renewals, interest, and sinking fund for wiring, alteration of lamps, and putting up of new lamps, amounts to £1,350. It is interesting to compare this figure with the cost that would be incurred were the whole exhibition lighted by gas. For this purpose I assume that each cubic foot of gas burned in Argand burners gives three candles for one hour. The total light now supplied per annum is 26 million candle hours. With gas the account would stand as follows:—

Gas bill, 8,650,000 cubic ft.	£1,190
Renewal of burners, glasses, shades	40
Alteration of lights and new lights .	100
Wages for cleaning and repairs	100
8 per cent. interest and sinking fund on £1,500	120
Total..............	£1,550

That is £200 more than the electric light costs.

Messrs. Bainbridge & Co.—This installation was designed and supplied by Messrs. J. H. Holmes & Co., of Newcastle, to whom I am indebted for the following information. The generating plant consists of two 16 and one 9 horse-power nominal Otto gas-engines, and three "Castle" dynamos of corresponding size. No batteries are used. There are 312 lamps installed of 200, 32, and 16 candle-power. The cost of the generating plant was about £1,300 or £26 per kilowatt. The working cost during last year was as follows :—

	£	s.	d.
Gas (2,058,700 cubic ft., at 1s. 10d., less 10 per cent. discount)	169	16	10
Water	15	0	0
Petty stores	8	2	0
Engine repairs	6	17	8
Electric repairs	7	4	3
Wages	82	16	0
8 per cent. interest and sinking fund	104	0	0
Total..........	£393	16	9

During the year, 50,850 units were supplied to the lamps, and the cost per unit works out at 1·855d., an economic result on which both the contracting firm and the owner may be heartily congratulated. The owner estimates that the electric installation gives him fully 25 per cent. more light whilst using 42,000 cubic feet less gas than in 1889, when his premises were lighted by gas.

Constitutional Club. — Messrs. Verity Brothers, the contractors for this and the next two installations, have been good enough to supply particulars referring to the three installations. The generating plant at the Constitutional Club consists of two Armington Sims engines driving Edison dynamos. No batteries are used. The steam from the boilers is required for lighting and other purposes, so that I am not able to give the working expenses in the list. The installation is given in the list principally to show the load factor. Over 1,000 lamps are installed varying from 32 to 8 candle-power.

Arts Club.—The generating plant consists of a 6 horse-power Stockport gas-engine, $5\frac{1}{2}$ kilowatt Electric Construction Corporation dynamo, and a battery of 54 L23 E.P.S. cells. Cost of plant £520, or £94 per kilowatt. The yearly supply is 10,800 units, and the working cost is as follows :—

	£	s.	d
Gas (873,000 cubic feet at 2s. 9d.)	£120	0	0
Petty stores	10	10	0
Repairs	5	0	0
Wages	36	0	0
8 per cent. interest and sinking fund ..	41	10	0
Total........	£213	0	0

or 4·726d. per unit, which is much less than the supply from a central station would cost.

Duke of Fife.—This is also a gas power installation, the generating plant consisting of a 14 nominal horse-power Otto engine, a 21 kilowatt dynamo, and a battery of 52 K type cells. Cost of plant £850, or £48 per kilowatt. Originally the cells were of the L type, requiring a smaller charging current over a longer period, and it was found that by substituting cells of the K type, which take a larger charging current over a shorter period, 25 per cent. of the gas previously required could be saved, the reason being that the engine now works at a more economical load.

Sir David Salomons.—This is a very complete illustration, and contains a large amount of plant required for engineering and scientific research work. The actual capital outlay and working expenses can, therefore, not be taken as applying to lighting only. Sir David Salomons has been kind enough to give me, as nearly as he could estimate it, that part of the cost which he considers legitimately chargeable to lighting. He estimates the capital outlay of all lighting plant at £10 per 16 candle-power lamp fixed, of which £3 represents the cost of wiring and fittings. This brings the cost of generating plant to £1,550. The motive power is gas, and three batteries are used. The total supply used is 4,390 units, and the cost is as follows :—

Gas (372,300 cubic feet at 3s. 2d.)	£58	15	9
Petty stores	1	12	3
Repairs	3	0	0
Battery renewals*	100	0	0
Wages	44	4	0
8 per cent. interest and sinking fund..	124	0	0
Total......	£331	12	0

or 18d. per unit.

* The figure given for battery renewals is very high. Sir Salomons writes on this point, "Apart from all calculations, I set aside £100 a year for cells, this being a close average over seven years."

Three other installations are given in the Table which I need not describe at length, as except in size they do not materially differ from those already mentioned. On looking over the Table, you will see that the load factor is the most important item as regards cost per unit. You will also see that, in installations for business purposes, the cost per unit comes out much lower than what is charged by supply companies. On the other hand, the comparison is in favour of the supply company when the light is used for domestic purposes. It must, however, not be forgotten that, when glow lamps become cheaper, this difference in cost can be reduced.

DISCUSSION.

Mr. Fletcher Moulton, Q.C., said that he was one of those who at one time made their own electricity, but he retained his peace of mind during that period by steadily abstaining from learning in any way how much it cost him. It appeared to him that unless the scale on which electricity had to be produced was fairly large, it never could pay any private person to generate his own electricity. They must have a competent staff, or else not only would the coal or gas bill be very high, but the expense of the batteries would be simply ruinous. Almost all the successful installations mentioned in the paper were those in which batteries were not used, and from his own experience, he should say that unless one had time to spend on the batteries one's self, or obtain the services of some enthusiast, who took as much care of his batteries as a really good stableman did of his horses, because he loved them, it was not possible to estimate what would be the cost of renewal. This was a most serious item in every domestic installation, and inclined him always to dissuade anyone who suggested a private installation from attempting it. The general principles exemplified in the paper might be summed up in this way: on looking over the cost sheet, they might take almost any liberty with the small items, provided it produced a good effect on the big ones. Take the case of over-running lamps. It had been shown that by so-doing they halved the life of the lamps; that they would run only 700 hours instead of 1,500, or, as he should say, they would run 400 or 500 hours instead of 800 or 1,000; but that was not important if the lamp renewal was not a big feature in the whole bill. To take the examples given, of one house only occupied for a short period each year, and another occupied almost continuously; if you ran the lamps at the same voltage, it was clear that in the first case the lamp renewal would be a small item; and, therefore, it was one they might safely take liberties with, and they could afford to double that item, if by so doing they could reduce what would be a big item in such a case—the capital expenditure necessary to produce the light at all. As he listened to the paper, it occurred to him that almost all the examples given might be explained in accordance with the rule he had given, viz., to pay attention to the big items, even if they took liberties with the small ones; and he thought the Chairman, with his great practical knowledge, would agree that that would be the best practical maxim for persons who wanted economical results.

Mr. F. Bailey said that two illustrations had been given in which gas engines were used; but sufficient attention had not been drawn to the trouble and difficulty entailed by the use of a gas engine. It would not start itself, and though one heard about gas engine starters, they did not always work satisfactorily. By the aid of the butler, cook, and housemaid, all tugging at the fly-wheel, you might get it started, but there was probably nothing dirtier than the fly-wheel of a gas engine, and what came off it on the hands no soap that he knew of would remove. One of the most important lessons to be derived from the paper was the absolute necessity of intending users of the electric light employing a consulting engineer of standing and repute, who would tell them what they ought to get, and see that they got it. In many cases a man who wanted the electric light was more or less influenced by the eloquent tout who came round, and gave an order somewhat recklessly for his house to be lighted, irrespective of the number of lamps, and when it was furnished, he was perhaps appalled, not only at the length of the bill, but at the number of lamps he had in his house. Probably that was one reason why some people had found electric lighting somewhat expensive. It seemed ridiculous that an architect should always be called in when a house had to be built or repaired, or a doctor at the least ache or pain, and yet an electrical engineer should not be consulted on a matter equally important.

Mr. G. L. Addenbrooke said that the question of the overrunning of lamps was now assuming very great importance, and he did not think Mr. Kapp had said all he might in favour of it. When the lamps were to be overrun, a less number would be required, and, therefore, the capital cost would be reduced to a certain extent, though, of course, this would not apply to the case of single lights in passages, and so on. Mr. Kapp said that by increasing the voltage 2 per cent. you got about 8 per cent. more light; but from a paper which Dr. Fleming gave him recently, he estimated that the gain would be nearly 12 per cent. In fact, he had worked out a small table, from which it appeared that, within the Board of Trade limits, the gain or loss was about one candle-power per volt; *i.e.*, if you ran 100 volt 16-candle lamps at 102, you got nearly 18 candles; and, on the other hand, if you ran them at 98, you got about 14 candles, or very nearly 12 per cent. difference.

Another point was that not only was the quantity of light increased, but its character was improved. Captain Abney had shown very clearly that, with a given quantity of light, the eye was able to appreciate objects differently, according to the colour of the light; as the light got whiter, the penetrating power of the eye increased. In this way also there was a gain by overrunning, and, at any rate, it would remove a very common defect in London lighting, that of under-running. Many lamps run on central stations were much below their proper candle-power—98 volts, he feared, was very common—not altogether due to the central station, but to want of care in making the installation, as well as to loss in the mains. If you got down to anything like a voltage of 98 or 96, you not only got a disagreeable light from each lamp, but had to increase the number; and, he feared, a great deal of work was put up on that principle. Of course, the difficulty of changing the lamps in some situations—as in a lofty room, for instance—had to be considered, but that would not, generally, be a very serious matter.

The CHAIRMAN said that the first point which occurred to him, as arising out of the paper, was that the cost of private lighting was not so heavy as many persons expected; and, in that respect, he had had a very favourable personal experience, for he had had his lighting changed from gas to electricity nearly two years ago, and, being one of those inquisitive persons who liked to know what they were paying, he kept a very accurate account of the cost, including lamps and everything, and found that, since he used electricity from a central station, at 8d. per unit, his lighting bill had gone down, not very much, of course, but still there was a perceptible decrease, and this he attributed to the way in which the lamps were arranged. He had taken care that, in every room, at least one lamp was controlled by a switch near the door, and this made it possible for the rooms to be left in darkness until they were wanted; anyone going in had the switch handy to turn on one light, and could turn on more afterwards if necessary, and everybody was enjoined, to use the switch at the door, and turn out the light on leaving a room. He was glad to say that his household were so well regulated that they really did so, and the consequence was that his lighting bill had gone down, although the price of 8d. per B.T.U. corresponded to 6s. 8d. per 1,000 for gas, and the price of gas in Kensington was only 3s. or 3s. 1d., so that the cost of electricity ought to have been about double. He could not agree with Mr. Kapp that the company charged large and small consumers the same, because they gave discounts, and large consumers, or those who burned the lamps for long hours, got an advantage, if they exceeded a certain number of units per lamp. The principal point was that a low first cost must be considered in connection with economy in the working, and a few pounds laid out in excess of the lowest tender would probably recoup the consumer in a very short time. That was a point where the consulting engineer would come in very useful, because a man who made these matters his study, naturally knew the points which ought to be regarded in the first installation better than the man who had only one sort of installation to go by. He was sorry to see that Mr. Kapp had introduced a load factor different from the one generally accepted. In his table he had given a column showing the total capacity of the generating plant in kilowatts; for instance, at the Constitutional Club this was 100, but he said the maximum load observed at any time was 45 kilowatts; and he afterwards spoke of the load factor as 29·6 per cent., which he said was much in excess of that of a central station, where they were glad to get 15 per cent. He did not say that he counted this load-factor on the 45 kilowatts, but, as far as he knew, in the central station the load-factor was calculated on the total possible output of the station, if it ran the whole year at the full; capacity and as this 45 kilowatts out of 100 was about 1 to 2, it would reduce the load-factor in this case, calculated in the same way as the central station factor was calculated from 30 to 15 per cent. Another point which he rather took exception to was that Mr. Kapp stated that an Argand burner only gave 3 candles per cubic foot of gas per hour, and though gas was the great enemy electric lighting had to contend with, he thought that they ought to give it credit for being able to produce 5 or 6 candles per hour in properly arranged burners. The paper had made it quite clear that there were a great many factors to be considered in electric lighting, and that a low first cost was not always the most advantageous.

Mr. A. F. PHILLIPS said that 3 candles per cubic foot per hour was about right for London gas with the standard burner, which ought to produce 16 candles burning 5 feet per hour.

Mr. MOULTON said that the Wenham or Siemens regenerative burners would give about 6 cubic feet per hour, but not the ordinary Argand burner.

Mr. KAPP, in reply, said it was necessary to compare small gas burners with small glow lamps, as in a place like Tussaud's, where numerous points of light equally diffused were requisite. Two or three large Wenham burners up in the roof would not serve the purpose. He made the comparison with Argand burners, which came the nearest to the 16-candle power glow lamp. He was very pleased that Mr. Moulton had laid down the law so lucidly with regard to large and small items. As children they were told to take care of the pence and the pounds take care of themselves, but Mr. Moulton had reversed this, and he thought any engineer would endorse his view when he said take care of the big items and let the small ones take

care of themselves. Mr. Bailey had rather over-estimated the trouble of starting a gas-engine; those at Tussaud's, and in many other places, are started by electric power, and there was no need to start a gas-engine by hand if they had a battery. He was obliged to Mr. Addenbrooke for having corrected his statement with regard to the advantage of over-running lamps. When he said 8 per cent, it was more or less a rough guess, and he was glad to have the correct figure; the rule of one candle per volt, when they departed from the normal, was very useful. With regard to the other point, which Mr. Addenbrooke mentioned as an advantage, that a lamp at a higher pressure had a more searching light, he thought the less said about it the better. Ladies had a great deal to say in the matter of fitting up an installation, and in the early days, when he was called upon to advise with regard to several country houses, the ladies often used to say, "Cannot you tone that light down"? As regarded the Chairman's remark that the large and small consumer were not charged exactly alike, he foresaw that the point would be raised, and he thought his statement in the paper would be found correct, though he might not have made it clear in reading. He did not mean to say that the man who bought a large quantity paid the same price as the one who only purchased a small quantity; the big buyer had a discount. But his contention was that the big buyer was not charged 3d. per unit, and his next door neighbour 8d. The company charged each 6d., and gave a discount to any one who consumed over 35 units per lamp; so that the method of charging was alike, though they had not both the same opportunity of taking advantage of the concessions. As regarded the load factor, he must own that the Chairman's criticism was justified, and he only wished he had told him how to calculate it. He was on the point of taking the load factor according to the custom of the central stations; but then there came the difficulty, that an installation which had a complete reserve plant, say, two 50 kilowatt machines, was not in the same position as a central station, where the maximum reserve was about 20 per cent., instead of 100. Consequently, if he reckoned it on the central station plan, he should have committed a greater error than he had in reckoning it on the observed output.

The CHAIRMAN then proposed a vote of thanks to Mr. Kapp, which was carried unanimously, and the meeting adjourned.

General Notes.

MUNICH ART EXHIBITION.—Information has been received from the Science and Art Department that the annual Exhibition at Munich will, in the future, as in the past, be organised by the Munich Künstler-Genossenschaft, and not by the Verein bildender Kunstler Muchens. H.R.H. the Prince Regent has placed at the disposal of the Künstler-Genossenschaft for the Exhibition of 1893, the whole of the Royal Glaspalast, which is the property of the State. The society will, moreover, be supported, as usual, by the Bavarian Government. Artists of all nations are invited to compete.

ANTWERP INTERNATIONAL EXHIBITION, 1894.—An International Exhibition is to take place at Antwerp next year, commencing on May 5, and remaining open for at least six months. In connection with the Exhibition, the Antwerp Royal Society of Fine Arts will hold its exhibition of painting, sculpture, engraving, and architecture, to which foreign artists can contribute. Nautical, Colonial, and African Exhibitions are also to be held. A circular, issued by the Executive Committee (which has been communicated to the Society by the Science and Art Department), says:—"The Antwerp International Exhibition of 1894, although originally due to private enterprise, has been favoured with the special patronage of his Majesty the King, the official support of the Government, and the active co-operation of the City of Antwerp." The committee add:—"The Exhibition buildings will be located in the new quarter of the city, near the River Scheldt and the new marine installations; they will cover an area of about 75 acres, and will be connected with the railway. The general plan provides for the erection of more than 100,000 square yards of covered galleries."

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock:—

APRIL 26.—H. VAN DER WEYDE, "The Pictorial Modification of Photographic Perspective by the use of the Photo-Corrector or Visual Lenses in Portraiture and Landscape."

MAY 3.—Prof. SILVANUS P. THOMPSON, F.R.S., "Practical Electrical Problems at Chicago." W. H. PREECE, F.R.S., will preside.

MAY 10.—J. B. HILDITCH, "The Richmond Lock and Tidal Wear."

MAY 17.—F. E. IVES, "Composite Heliochromy."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

APRIL 27.—SIR JULAND DANVERS, K.C.S.I., "Indian Manufactures: their Present State and Prospects." SIR ALEXANDER WILSON, formerly President of the Bengal Chamber of Commerce, will preside.

MAY 18.—SIR RAYMOND WEST, K.C.I.E., "Agrarian Legislation for the Deccan, and its

Results." The Right Hon. Sir James Fergusson, Bart., G.C.S.I., K.C.M.G., C.I.E., M.P., will preside.

Foreign and Colonial Section.

Tuesday evenings at Eight o'clock:—

May 2.—E. Delmar Morgan, "Russian Industrial Art." J. Hungerford Pollen will preside.

May 16.—W. B. Perceval, Agent-General for New Zealand, "Aspects of Federation."

Applied Art Section.

Tuesday evenings, at Eight o'clock:—

May 9. — Prof. W. M. Flinders Petrie, "Primitive Art in Egypt." Edward J. Poynter, R.A., will preside.

May 30.—James Dallas, "Devonshire Pottery." C. M. Kennedy, C.B., will preside.

Cantor Lectures.

Monday evenings, at Eight o'clock:—

Lewis Foreman Day, "Some Masters of Ornament." Four Lectures.

Lecture III.—April 24.—The latter Renaissance—The Netherlands—Louis XIII. and the beginning of the Baroque—With illustrations of the works of Virgil Solis, Floetner, G. Tory, Le Petit Bernard, Hurtu, Fontin, La Quvevellerie, Jost Amman, G. Wechter, B. Zan, P. Flynt, W. Dietterlin, G. Bang, A. Collaert, J. V. de Vries, H. Janssen, S. Vouet, and others.

Lecture IV.—May 1.—The French styles—Louis XIV., Louis XV. and the Rococo—Louis XVI. and the revival of Classicism, and the Empire—With illustrations of the works of Le Pautre, Le Brun, Jean Vauquer, Jean Berain, D. Marot, A. C. Boulle, Claude Gillot, Watteau, G. M. Oppenort, F. de Cuvilliés, J. A. Meissonier, Cauvet, Gouthiére, C. P. Marillier, La Londe, Salembier, Passarini, and others.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 24 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis F. Day, "Some Masters of Ornament." (Lecture III.)

Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. 1. Committee's Report on "Hill's Non-Automatic or Confidence Water-Meter." 2. Mr. G. H. Gemmell, "Micro-Organisms in Drinking-Water in relation to Public Health."

Surveyors, 12, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. T. Bright's paper, "Underwoods, their Growth and Utilisation." 2. Mr. R. F. Grantham, "Recent Experience in Sewage Filtration considered in Relation to River Pollution."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Hon. G. N. Curzon, "Journeys in French Indo-China."

Actuaries, Staple-inn-hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, April 25 ... Royal Institution, Albemarle-street, W., 3 p.m. Dr. J. Macdonnell, "Symbolism in Ceremonies, Customs, and Art."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on paper by the late Mr. P. W. Willans, "Steam Engine Trials."

Statistical, School of Mines, Jermyn-street, S.W., 8¾ p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Mr. J. Desiré England, "The Manufacture of Gelatine Plates."

Botanic, Inner Circle, Regent's-park, 2 p.m. Second Spring Exhibition.

Wednesday, April 26...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. H. Van der Weyde, "The Pictorial Modification of Photographic Perspective by use of the Photo-corrector, or visual lenses in portraiture and landscape."

Geological, Burlington-house, W., 8 p.m. 1. Mr. Charles Callaway, "The Origin of the Crystalline Schists of the Malvern Hills" 2. Messrs. Alfred Harker and J. E. Marr, "Supplementary Notes on the Metamorphic Rocks around the Shap Granite." 3. Mr. Herbert R. Wood, "Study of the Dykes of Hope, Idaho."

British Astronomical, Barnard's-inn Hall, Holborn, E.C.

Entomogical, 11, Chandos-street, W., 7 p.m.

Royal Society of Literature, 20, Hanover-square, W., 4½ p.m. Annual Meeting.

Thursday, April 27...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4½ p.m. (Indian Section.) Sir Juland Danvers, "Indian Manufactures: their Present State and Prospects."

Royal, Burlington-house, W., 4½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W. Second Conversazione, at the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Atmosphere"

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. Albion T. Snell's "The Distribution of Power by Alternate Current Motors"

East India Association, Westminster Town-hall, S.W., 2½ p.m. Sir Roper Lethbridge, "The Behar Cadastral Survey."

Friday, April 28...United Service Institute, Whitehall-yard, 3 p.m. Prof. C. V. Boys, "Photography of Flying Bullets by the Light of the Electric Spark."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Francis Gotch, "The Transmission of a Nervous Impulse."

Civil Engineers, 25, Great George-st., S.W., 7½ p.m. (Students' Meeting.) Mr. H. W. Handcock, "Fire-Risks of Electric Lighting."

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science Schools, South Kensington, S.W., 5 p.m. 1. Discussion on paper by Prof. J. Perry, and Messrs. J. Graham and L. W. Heath, "Experiments on the Viscosity of Liquids." 2. Mr. E. E. C. Rimington, "Luminous Discharges in Electrodeless Vacuum Tubes."

Saturday, April 29...Royal Institution, Albemarle-street, W., 3 p.m. (Tyndall Lectures.) Mr. James Swinburne, "Some Applications of Electricity to Chemistry."

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FRIDAY, APRIL 28, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the Imperial Institute, South Kensington (by permission of the Executive Council), on Wednesday evening, June 21.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member.

Further particulars as to the arrangements will be announced in future numbers of the *Journal.*

CANTOR LECTURES.

On Monday evening, April 24, Mr. Lewis Foreman Day delivered the third of his course of lectures on "Some Masters of Ornament."

The lectures will be printed in the *Journal* during the summer recess.

INDIAN SECTION.

A paper on "Indian Manufactures: their Present State and Prospects," was read by Sir Juland Danvers, K.C.S.I., on Thursday afternoon, April 27. Sir Alexander Wilson presided.

The paper and discussion will be printed in the next number of the *Journal.*

Chicago Exhibition, 1893.

SOCIETY OF ARTS EXCURSION TO CHICAGO.

The Council of the Society of Arts, acting as the Royal Commission for the Chicago Exhibition, have arranged with Messrs. Thos. Cook and Son to organise a special private excursion to the Chicago Exhibition for members of the Society of Arts. The excursion will last from July 22 to August 23, and will cost £65.

Those members who intend to avail themselves of this offer are requested to make early application to the Secretary, as the list will be closed on Saturday, May 13.

PASSENGER RATES TO AMERICA.

The Hamburg-American Packet Company offer to convey members of the Society of Arts to New York at a rate of £14, single fare, first-class, on the understanding that at least fifty members travel by this line during July and August. The company's steamers sail from Southampton every Friday.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Thursday evening, April 18, 1893; Charles Malcolm Kennedy, C.B., Vice-President, in the chair.

The paper read was—

THE PHILIPPINE ISLANDS.

By H. A. MacPherson.

It is doubtless unnecessary for me to tell you that the Philippine Islands are a Spanish colony, and that, lying to the north-east of Borneo and the south of Formosa, they form part of the continuous chain of islands which separate the Pacific Ocean from the China Sea.

The extreme length of the group is from 4° 45° to 21° North Latitude, or about 1,000 miles, and its extreme breadth from about 120° to 128° East Longitude, or some 400 miles. There are said to be some 600 islands. The bulk of these are, of course, of small importance, but the extent and richness of the larger islands fully justify the title which the Spaniards have given to the group of "Perla del Oceano," the Pearl of the Ocean.

I purpose confining my remarks to the Philippines proper, although the Spanish possessions in the Eastern seas, which are all under the jurisdiction of the Governor-General of the Philippines, comprise the Marianas or

Ladrones, the Carolines, and the Pelew Islands, but these three groups are, so far, of comparatively small commercial value, their products consisting mainly of what may be described as South Sea produce, copra or dried cocoanut, *bêche de mer*, and other products of the forest and the ocean, which at present find their outlet rather through the commercial centres of the South Sea than through the ports of the Philippines. It may, however, be within your recollection that a few years ago, when the Colonial fever was at its height in Germany, the latter power attempted to occupy the island of Yap in the Carolines, and a collision nearly occurred between a Spanish and German war-ship, which bears some resemblance to the story of the British occupation of Perim. The Spaniards had maintained for centuries a shadowy claim to the islands, and in view of the activity which the Germans were beginning to display in these waters, they thought it advisable to give some visible evidence of their dominion. An armed transport was, therefore, sent down to Yap to formally hoist the Spanish flag, the natives were called together, and every arrangement made for carrying this out with great ceremony on the following day; but in the night a German gunboat slipped into port, and when the Spaniards came on deck in the morning they found the German ensign already flying. A fight very nearly ensued, but was fortunately averted. The matter was referred for arbitration to the Pope, who gave his decision in favour of Spain, and no attempt has since been made to dispute it. Personally, I am of opinion that these scattered groups of Pacific Islands (I do not, of course, refer to the Philippines themselves) will never be anything but a burden to Spain, and that she would have done well to cede her rights for a substantial monetary consideration to Germany; but probably no Spanish minister would venture to make a proposal so wounding to the patriotic feeling of his countrymen.

But, to return to my subject, the principal islands of the Philippines, as regards size, are in the order named--Luzon, Mindanao, Paragua or Palawan, Samar, Panay, Mindoro, Leyte, Negros, Cebu, Bojol, and Masbate. They are, as a rule, mountainous and well wooded and watered, and their extreme length being from north to south (their northern extremity almost reaching the limit of the tropical zone), there is considerable variety of climate and cultivation.

Although, as I have said, they form part of the chain of islands that run northward from Borneo, yet Wallace, in his charming book on the Malay Archipelago, shows that they are divided from this continental island by very deep water, proving that, although the strait which separates them is a very narrow one, the connection between them, if it ever existed, has ceased for a very long period. This is confirmed by the fact that the fauna of Borneo differs widely from that of the Philippines. The elephants, tapirs, and orang-outangs of the former are not found in the latter, whose animal life is of a somewhat restricted and insular character. There are no beasts of prey, with the possible exception of a *gato de monte*, or species of wild cat, the other wild animals consisting of buffaloes, deer, pigs (probably the descendants of domesticated pigs run wild), monkeys, and a somewhat mysterious animal, the tumarao, found only in the almost unexplored island of Mindoro, and described as being in appearance something between a buffalo and a deer.

The scenery as one journeys through the islands is of a most enchanting description. Blue seas, white coral beaches, bold mountainous coasts, wooded from base to summit, and here and there the cone of some volcano with its delicate plume of vapour or heavy cloud of smoke. Many of the mountains are very lofty; the highest are Mount Halcon in Mindoro, 8,868 feet, and the Mayon, in the province of Albay, 8,283. This noble specimen of a volcanic mountain rises almost alone, a perfect cone from every side, at the head of the Bay of Albay, and presents a most majestic appearance for miles out to sea.

Inland, although largely retaining its mountainous character, the scenery is more diversified; large lakes, considerable rivers, and broad alluvial plains add both to the beauty of the country and to its commercial capabilities.

Unfortunately, in spite of the length of time that it has been in European hands, the means of communication by land are of the worst description, though I hope that we are now at the beginning of a better era, for the first railway has just been opened connecting Manila, the capital, with the rice districts of Pangasinan, and I hope that this may be but the commencement of a network of railways opening up the remote districts of these beautiful islands both to trade and to travel. Hitherto the only means of getting about has been in most uncomfortable two-wheeled traps called carromatas, over most execrable roads, roads which, in the wet season, are frequently seas of mud, and only to be traversed by a

sort of sledge drawn by buffaloes. Inns, of course, there are none, but every village has its "Tribunal," or public building (often, of course, merely a native hut like the rest), where the traveller can put up, and be supplied with the necessaries of life: rice, eggs (of a more or less doubtful character), and sometimes chicken, of a most phenomenal toughness, at a tariff rate. Sleeping accommodation there is none, except the floor, and one always travels with a bundle containing pillows and a palm leaf mat to spread on the floor. Where, however, there are Spanish priests, which is the case in most villages of any importance, one is always sure of a welcome at the "convent," or priest's house, and I am sure that anyone who has travelled at all in the islands owes many a debt of gratitude to the members of the various religious orders who are scattered about the Archipelago, and who rarely fail to exercise the virtue of hospitality in its widest sense.

The climate of the islands, for a tropical climate, is good. The seasons vary with the monsoons or trade winds, which blow, speaking in general terms, from the north-east from November to April, and from the south-west from May to October, the former being the rainy season on the eastern watershed, the latter on the western. The effects of the monsoons are summed up in the Spanish proverb, which describes the year as "Seis meses de polvo, seis meses de lodo, seis meses de todo"—six months of dust, six months of mud, six months of everything.

Speaking of the western division, which contains the three open ports of Manila, Cebu, and Iloilo, and which is, therefore, of most interest to foreigners (a term which, in the Philippines, comprises everyone except Spaniards, natives, and Chinese), the greatest heat is felt about May, before the rains fairly set in, when the thermometer ranges from a minimum of about 80° to a maximum of close on 100° in the shade, and the coolest weather is in December and January, when the thermometer falls at night to about 65° (I believe that, during last winter, it fell below 60°), and rarely rises above about 75°. During these months, the climate is a most delightful one, cool, bright, and dry; and, in a London fog, with the temperature in the neighbourhood of zero, one is sometimes tempted to sigh for the bright genial climate of the East. As a rule, the Philippines enjoy one great advantage over some other portions of Malaysia—for instance, the Dutch Islands and our own Straits Colony—in the fact that there is always a considerable range between the maximum and minimum temperature of any period of 24 hours, which averages 10° Fahrenheit, and which I have known to reach 20°, from 72° to 92°.

The climate—always with the proviso "for a tropical climate"—is healthy for Europeans. Jungle fevers are comparatively rare, I might almost say, unknown; the most dangerous illness is typhoid fever, though, I am thankful to say, it also is but of rare occurrence among the foreign population. Still, as is the case with all tropical climates, a prolonged residence is enervating, and cannot but have a debilitating effect upon the constitution.

The islands lie on the line of volcanic activity which stretches from Japan to Java, and by which the terrible calamities of Krakatoa and Sanguir were caused. Nor have they been exempt. Numerous disastrous earthquakes are recorded in their history, the most recent being those of 1863 and 1880, which caused great destruction to property, and—at least, in the former case—great loss of life. Slight earthquakes are frequent, though generally harmless; still, they are among the few things for which familiarity does not breed contempt. The more experience one has of them, the more apprehensive one is apt to become; they are so sudden, so appalling sometimes in their effects, that man realises how utterly helpless he is against the forces of nature, and I think there are but few who have lived in such a land who can remain unmoved when the houses begin to rock, however softly, and they hear the muttered exclamations "temblor," an earthquake.

The native huts, built of bamboo and palm thatch, and perfectly elastic, suffer but slightly, the damage being mostly confined to the larger buildings; and, of late years, great improvements have been made towards rendering the European buildings also, to a great extent, earthquake proof. It is rare that stone or brick is used above the ground-floor, the upper storey (there are, practically, never more than two floors) being built of wood; the roofs are generally of galvanised iron, and supported by wooden pillars, which are attached to the beams and joists in such a way as to allow a certain amount of play, and quite independent of the walls; indeed, paradoxical as it may appear, the first step in building a Philippine house is to put on the roof.

Besides earthquakes, the islands are much exposed to the ravages of typhoons, those

scourges of the Eastern seas, and rare is the year in which a score or more of them do not make their influence felt to a greater or less degree. They develop in the Pacific, and, following a course from east to west, sweep over the islands, and either pass on and spend their force on the coasts and uplands of China and Cochin China, or recurve and lose themselves in the China Sea.

So far as the Philippines are concerned, the typhoon season is from about August to the end of the year. In the early part of the season they cross the northern portion of the islands and, as it advances, work gradually south, so that the dangerous zone in the latitude of Manila is about the end of October and the beginning of November, while towards the end of the year the southern islands are those which suffer. The typhoons never pass further south than the parallel of about $8\frac{1}{2}$ or 9° North Latitude, so that the greater portion of Mindanao, the great southern island, is free from their ravages.

The area affected may be very large; sometimes the typhoon is of great diameter and moving slowly, while at the others it is of small dimensions, but both its circular and progressive movements are from that very fact more rapid, and the direct havoc wrought by the force of the wind is all the greater. Still this is not all the damage these circular storms do; they are always accompanied by a fringe of heavy rain, which in the former class is naturally more widespread, and the indirect damage which they cause, coming as they do, especially in the southern islands, at the period when the crops are ripening, is very great. The fields of sugar-cane are flooded, the sap instead of rising goes back, the fuel is soaked, the roads rendered impassable, and each week's delay means so much sugar lost, for in the case of a good crop the planter requires all his time to harvest it between one wet season and another. In the case of the coffee crop also much loss may be occasioned, for it is just at the period when the fruit is ripening that the plantations are most exposed to this danger, and the fruit may be torn from the trees and lost.

In the case of the hemp plantations, which are perennial, the effect is peculiar; a disastrous typhoon is generally followed during the next few months by an abnormally large production, but this is due to the fact that the trees which are blown down may still be utilised for making hemp, if promptly worked up, and the effects are felt in a much reduced production later on.

It will thus be seen that the Philippines offer a most favourable opportunity for the study of two of the most appalling phenomena of nature, earthquakes and storms; and this fact has been taken advantage of by the Jesuits to establish an observatory, which I believe is recognised as one of the best, if not the best, in the East. Whatever our opinion may be of this society, no one can deny their wonderful capacity, for choosing the right man for the right place, and the priests who have had charge of the Manila Observatory, notably the late Director Padre Faura, have been chosen for their special aptitude for this branch of science. Without abandoning their priestly functions, they are temporarily relieved of them to a certain extent, in order that they may devote themselves to their technical duties, the importance of which can hardly be overrated.

No means has yet been discovered—it is doubtful if it ever will be—of foretelling earthquakes, though I believe Padre Faura was not entirely hopeless of success, and doubtless his researches are being ably continued by his successor. So far, however, in this branch, the labours of the observatory staff have chiefly been confined to reporting upon the disturbances as they take place, and tabulating their effects. It is different in the case of typhoons; these can be, and are, foretold with more or less of anticipation. The observatory is connected with the telegraph system of the Island of Luzon, and receives weather reports at least twice a day from the principal stations, the most important in this respect being those in the extreme east of the island, where the indications of the approaching storm first become apparent. Warnings are issued and signals hoisted at the semaphore stations, and prove of immense advantage to the coasting trade. They are also telegraphed over to Hong-Kong, so that the approach of any typhoon, which passes within touch of the Island of Luzon, is known in advance in that colony. The Jesuit Fathers are most courteous in furnishing any information or assistance that may be asked for, and the establishment of the observatory, the cost of which falls I believe mainly, if not entirely, on the order, has been a great boon to the islands.

The dominant people among the natives is to-day, and was indeed at the time of the Spanish occupation, a branch of the Malay race. But the original inhabitants of the islands -- whose descendants, now called

Negritos or Aetas, are still found in some of the remote and mountainous districts—would seem to have been allied to the Papuans of New Guinea, their hair being woolly, and their faces of the Negroid type; while the bulk of the natives have the smooth hair and flat faces of the Malays. The language, too, is undoubtedly a form of Malay, and, in the southern islands especially, is closely connected with the Malay spoken in the Straits; but in process of time it has become much corrupted and altered, so much so that the inhabitants of some districts have great difficulty in understanding those of others. The principal divisions of the language are Tagalo, Pampango, Ylocos, Cagayan, Vicol, and Visaya, and, in many cases, these are subdivided into dialects.

On their first arrival the Spaniards found that the natives with whom they came in contact possessed a certain amount of civilisation. They had a written language, of which some few specimens have been preserved, though not of any value as throwing light on their former history; no historic remains of any kind are extant, and their traditions are of the most slender description. Doubtless the Spanish priests, in the crusading zeal of the early days, did all in their power to extirpate such mythological and other lore as existed, and unfortunately with almost complete success.

Although the bulk of the natives are now civilised, and profess the Roman Catholic religion, there still exist in parts of Luzon and Mindanao, in addition to the Negritos whom I have already mentioned, a considerable number of savage tribes in a state of semi-independence, who frequently prove most unpleasant neighbours to the more civilised portion of the inhabitants. In the Island of Mindanao, in fact, the Spaniards only hold part of the coast line. The interior is an almost unknown country, inhabited partly by pagan tribes, partly by Mahomedans, the latter of whom are known to the Spaniards by the generic name of "Moros" or Moors.

Mindanao is at some distance from the capital, and is, as I have said, only occupied on portions of the coast. There is, therefore, some excuse for the fact that it has not been brought thoroughly under Spanish rule, but the same cannot be said for Luzon, where the Spaniards have had a footing for more than 300 years, and the greater part of which is perfectly civilised.

The savages of Luzon consist of two main divisions, the Tinguianes and Igorrotes. It seems generally admitted that the latter are of the same race as the civilised natives, but several theories exist as to the origin of the Tinguianes, who are of a lighter colour, and differ somewhat in their facial characteristics. Some hold that they are descendants of Chinese or Japanese, though there is no trace of this in their language; some that they came originally from Persia or the Red Sea; while, in some theories, I seem to see a disposition to put them down as the descendants of the lost tribes. The customs of these two divisions are, in the main, very similar. They pay no tribute, and submit to no law but their own; they cultivate rice and tobacco in the mountains, which they barter with the dwellers in the plains; they live principally by hunting, and occasionally amuse themselves by raids on the neighbouring villages, or by small wars among themselves, it being considered etiquette that when any person of importance dies, a certain number of innocent strangers should be killed to bear his spirit company; and this naturally leads to reprisals. These people used not to be entirely free from a suspicion of cannibalism, and in former times they sold their prisoners, if they could find buyers. This led D. Sinibaldo de Mas, who wrote a very full account of the islands some fifty years ago, to propound the rather ingenious theory that the best way of dealing with these savages would be to devote a certain sum yearly to buying their prisoners, in order to deport them to the other islands and gradually civilise them, the system having the contingent advantage that it would lead to continuous fighting among themselves, tending to reduce their numbers and to prevent their uniting against the central government. However, neither this plan nor any other radical one has ever been adopted, and while admitting the difficulties occasioned by the inaccessibility of the forests and mountains, on which they have their homes, I cannot but regard it as a blot on the Spanish administration that no means has been taken to bring them into subjection.

The wild tribes, however, form but a very small portion of the inhabitants, who are, as a rule, a peaceable, well-behaved race.

I have found the hardest task in this paper is to endeavour to give you some idea of the civilised portion of the natives, those with whom we come in contact. In addition to the fact that they differ considerably in their characteristics in different provinces, they are so contradictory in themselves that it is very

hard to generalise. They are so utterly stupid in some things, so quick and intelligent in others, sometimes so lazy, sometimes so hard-working, that it is almost impossible to speak of them in general terms. They are a medium sized, rather a small, race, but well built and wiry. In colour they vary from very dark to pale olive, the latter, especially about Manila, where the race has not remained so pure as inland. Their features are often good, especially their eyes ; their hair is black and straight, but coarse, and in the case of the women often of extraordinary length and thickness. The men dress in trousers, generally white, and a shirt of calico or piña, a native fabric woven from pineapple fibre, the shirt being worn outside the trousers. The women wear a short loose camisa or blouse, cut rather low at the neck, and reaching to the waist, with wide sleeves, a large well-starched handkerchief round the neck, so folded that it stands up rather high at the back, and crossed and fastened with a small brooch in front, the camisa and handkerchief being generally made of piña and often beautifully embroidered. The costume is completed by a loose saya or skirt, generally of bright colours, the upper part being confined by the tapis, a straight piece of dark material wound round the waist and reaching to the knees.

In character the natives are a peaceable easy-going race, fond of amusement, especially gambling and cock-fighting, to the latter of which they are passionately addicted, very talkative, and fond of company. They are generally civil and obliging, make very fair servants (though, of course, we always grumble bitterly about them while we are out there), and very good subordinate clerks in offices, as they often write most beautifully and are quick at figures. They are about the best of all native sailors, and make fairly good subordinate engineers. They have considerable artistic taste, and some of them have displayed very fair talent in painting. They are very fond of music, there being hardly a village that does not possess its band, and those of the native regiments, which play every evening on the Paseo or Promenade, can compare favourably with any except the very best bands in a European army.

They are most devout Roman Catholics, at least in all outward and visible forms. Every parish has, of course, its patron saint, whose festival is celebrated with great display. The principal feasts and fasts of the Church are kept up with extraordinary devotion. From the morning of the Thursday in Easter week to that of Saturday no carriages or horses are allowed in the streets, and all the vessels in harbour fly their flags half-mast. The religious processions on these holy days are really most noteworthy, during one of them, that of Corpus Christi, the Spanish flag is laid down in the street, and the Archbishop walks over it, as a sign of the temporal power of the Church.

I am decidedly of opinion that the influence of the Spanish clergy over the natives is in the main a most beneficial one, politically as well as morally, and that the tranquillity of the country is largely due to them. In many districts they are the only white men with whom the natives come in contact. In their parishes they are supreme, and they are a much more visible sign of Spanish rule to the bulk of the natives than any Government official.

Having now given you, to the best of my ability, though I am afraid very poorly, some idea of the country and its people, I will endeavour to give you a short résumé of its history, both political and commercial.

The Philippines are, as you doubtless know, the second in importance of the colonies which remain to Spain of all her noble colonial possessions. Fortunately for the inhabitants, fortunately perhaps, too, for the mother country, they were treated during the period of conquest in a much more merciful manner than many of her other colonies. Whether this was owing to experience already gained, to the influence of the priests, to the early establishment of the Audiencia or Court of Appeal as a check on the power of the Governors, or to the fact that the search for gold, which led to such cruelty and oppression in the American colonies, was not the object of the first discoverers, I am unable to say; but, speaking broadly, the natives of the Philippines have always been well treated by the Government, and, under Spanish rule, they have increased and developed, instead of becoming exterminated, as in the West Indian Islands.

When Pope Alexander the Sixth divided the world, so far as it was not already occupied by other civilised powers, by a line drawn north and south 100 leagues west of the Azores, he gave the western half to Spain, the eastern to Portugal. Disputes soon arose as to the right to the Moluccas. These had already been occupied by the Portuguese, proceeding by way of the Cape of Good Hope, but Hernando de Magallanes—Magellan, as

we call him—offered Charles V. of Spain to take a fleet there by a western route through what we should now call the Spanish "sphere of influence." In the course of this voyage he discovered the Straits which bear his name, and standing on to the westward, somewhat to the north of his proper course, he discovered the Philippine Islands on St. Lazarus's Day, 1521, and named them the Archipielago de San Lazaro. He touched first in Mindanao, and next in Cebu, where he was well received by the chief, but he was soon afterwards killed on the Island of Mactan, in an expedition in which he lent his aid to the natives of Cebu against those of Mactan. After this, disputes arose with the islanders, others of the Spaniards were killed, the squadron proceeded to the Moluccas, and ultimately one vessel, commanded by Sebastian El Cano, reached home by way of the Cape of Good Hope in September, 1522, being the first vessel to circumnavigate the globe.

Several expeditions were despatched from Mexico by the Court of Spain, from this time until 1542, to take possession of the Philippines and Motunas, but all failed until, in 1565, an expedition, commanded by Miguel de Legaspi, made good a footing in the islands. At first Cebu was made the head-quarters, but, in 1571, they were transferred to Manila, which has since remained the capital, and from this time the islands were gradually brought under the dominion of Spain. Risings among the natives took place from time to time, but were always put down, and although the colony was frequently threatened from without, it has never been wholly lost to Spain since Legaspi first took possession of it. The attacks were mostly mere raids, sometimes merely piratical raids, first by the Portuguese, who viewed with much disfavour the rise of Spanish power in the East, and afterwards by the Dutch. The only really dangerous attacks, however, were those of the Chinese pirate Li Ma Hong, in 1754, and of the English, in 1762. Li Ma Hong had a powerful fleet of ninety-five war junks, and the colony was yet in its infancy, but the Spaniards made a valiant defence, the pirate was driven to his ships, and retreated on the 30th November, St. Andrew's Day; and San Andres has ever since been the patron saint of Manila. The English invasion was a more formidable affair. War was declared between England and Spain in 1761, and in 1762 the East India Company despatched a force of thirteen ships and a body of English and Sepoy troops to capture the islands. Manila was occupied, after a short siege, on the 4th October, and from this time, until March 1764, the town and neighbouring country were held by the English; but a guerilla warfare was carried on by the Spaniards and natives, under D. Simon de Anda, and no great advance was made towards the reduction of the islands until the conclusion of peace between England and Spain, after which Manila was evacuated.

With these exceptions, the political history of the islands is made up more or less of local questions, disputes between the different authorities, between Church and State, between the different religious orders, expeditions to subdue the outlying islands and to keep in check the Dyak pirates from Sulu and Borneo, one or two risings and subsequent massacres of the Chinese, and one or two military outbreaks, all of which would prove of but little interest to you; and I shall now attempt to sketch out in a little more detail the commercial history of the colony.

There is evidence to show that, prior to the Spanish discovery of the Philippines, a considerable intercourse was carried on with the surrounding countries and islands, especially with China and even Japan. When the Europeans first landed at the mouth of the river Pasig, at the town which was even then called Maynila, they found it defended by a stockade mounted with light cannon, showing that the use of gunpowder had been introduced from China. In its earliest stages the commerce of the islands was doubtless carried on by barter, for the natives had no coined money; but gold dust, which was even then found in the rivers, seems to have been employed by weight as a standard of currency, which was computed by the Chinese tael.

Very soon after the Spanish occupation, the Europeans came in contact with the Chinese and Japanese traders, and a fresh impetus was given to trade. However, the mere exchange of island produce against the imports from China was not found sufficient, and a larger sphere was necessary. This was found at first, and for many years afterwards, in the trade between Manila and the Spanish Central and South American colonies.

In order to maintain communication between his new possession in the Eastern seas and his older ones in America, a King's ship was despatched every year from Mexico to the Philippines, and from the Philippines to Mexico, the American port of departure being first that of Navidad and afterwards that of Aca-

pulco. These vessels, called by the Spaniards "Los Naos de Acapulco" and to us better known as the Spanish galleons, continued their voyages until the beginning of the present century, the last *El Rey Fernando*, being despatched from Manila in 1811, and from Acapulco in 1815. In addition to their Government services, they soon began to be utilised as merchant ships carrying the produce of China and the islands to Mexico, and thence to Europe, and bringing back silver in return; and they furnished at times a rich prey to English and other cruisers, the most celebrated cases being the capture of the *Santa Anna* by Thomas Candish, in 1587, off the coast of California, after which he returned to England "with sails of Chinese damask and ropes of silk," and that of the *Nuestra Senora de Cavadonga* off the entrance to the Straits of San Bernardino, in 1740, by Anson, in the course of his famous voyage round the world in the *Centurion*.

Manila soon became an extensive entrepôt for the trade between the East and the West.

The Chinese junks made a yearly voyage, running down with the north-east monsoon, and, after disposing of their cargoes and taking in a return freight, availing themselves of the first of the south-west monsoon to return to their native country.

At first the merchants and supercargoes came and returned year after year; but before long some began to remain behind, finding it more profitable to retail their goods gradually than to force them off during the few weeks during which the junks remained, and in competition with the other traders. This was the beginning of the Chinese colony, which, in spite of vicissitudes, and more than one massacre, has gone on increasing ever since, and has been, and still is, the backbone of commerce in the Philippine Islands; for, with all his faults, the Chinaman is a born trader, the most hard-working and contented with small profits of any in the world, a man of his word in commercial transactions, and with broad views of business.

The cargoes of the junks were of a most miscellaneous description, forming what the Americans would call "cargoes of notions." They comprised raw and spun silk, damasks and satins, velvets and brocades, cotton, linen and grass cloth, musk, ivory, and precious stones, iron and copper ware, sheet-iron, tin, and lead, saltpetre and gunpowder, wheat, flour, fruits, fresh and preserved, salt pork, fowls, geese, caged birds, ponies, crockery and chinaware, and curios, "to recount all which, as one of the old chroniclers says, "would be never to come to an end, nor would much paper be sufficient for it."

On arrival in the roadstead, the junks were boarded by the royal officers, lists and valuations were made out, and a duty of three per cent. paid, after which the goods were landed, and disposed of to the Spanish and native merchants, it being ordered, by royal decree, that the Chinese traders should enjoy perfect freedom and liberty in their transactions.

De Morga, whom I have quoted above, says of them:—"They are very experienced and intelligent people in trade, and of great coolness and moderation for the better carrying on of their business; and they are ready to trust and give liberal facilities to whomsoever they know deals with them honestly, and will not fail in his payments at the due date," an opinion which, I think, will be endorsed by anyone who has had dealings with the Chinese of to-day.

In return, they took almost exclusively silver coin, those "pieces of eight," or dollars, of which we hear so much in the old histories of the English privateers and freebooters, and which, in the modern form of Mexican dollars, are still the principal currency of the Far East.

As time went on, the commercial value of Manila, as the emporium of the Eastern seas, increased, and, by the year 1600, we find that, in addition to the Chinese junks, junks came from Japan with similar cargoes, taking in return deers' horns and dyewoods, honey and wax, palm wine and Spanish wine, and cloth and other Spanish manufactures. The Paraos, from Borneo, brought palm leaf mats, sago, camphor, and slaves, which they exchanged for rice, wine, and cotton ware. A few vessels came from Siam and Cambodia, bringing pepper, ivory, rubies, and sapphires, rhinoceros horns and hides, and taking return cargoes of Philippine and Spanish goods; and a few Portuguese ships came each year from Malacca and the Moluccas with cloves, cinnamon, and other spices, cotton cloths, muslin, and gauze, jewellery, Turkish and Persian carpets, and other Indian goods, taking, in return, for the Moluccas, wine, crockery, and other things, but for Malacca only gold and hard cash.

Besides the Acapulco ships, no European vessels, except Portuguese, were allowed to trade with the islands, but a few came in occasionally under the flag of some Malay State, with natives acting nominally as captains, the real masters appearing as supercargoes.

It will be seen that the traffic between the Philippines and the neighbouring countries was fairly free, but the trade with Europe was a strict monopoly, and was carried on entirely by way of Acapulco, and by means of the galleons. These were, as I have said, King's ships, and no others were allowed to make the voyage. The trade was strictly confined to persons established in the Philippines, and possessing certain qualifications, those resident in the Spanish American colonies not being allowed to take part in it.

It can thus readily be imagined that it was a very lucrative trade, and that there was a great demand for permits to ship. These permits, or "boletas," were issued by the Governor-General, after due inquiry had been made into the means and standing of the intending shippers, and the following description, by D. Tomas de Comyn, gives a graphic account of the abuses of the system. He says :—

"It is a necessary condition that every shipper should be a member of the Guild (Vocal del consulado) which presupposes a residence of some years in the Philippines, and a capital of $8,000. The bales have to be made up in a fixed shape and to fixed dimensions, and have to be shipped in one single ship, commanded and organised as a ship of war. The shipper has to bear his share of the honorarium of $20,000 paid to the commander, and he has no voice in the choice or class of the vessel, although he risks his capital in her, and, to complete the absurdity of the system, he has to pay, according to circumstances, 25 to 40 per cent. of the value of the goods as freight to the clergy, councillors, subaltern officers, and widows of Spaniards, to whom a certain number of the permits are given as a compensation for their low salaries, but with the understanding that, as they are not members of the guild, their only right is to sell the permits to such members; and, so great is the competition to ship, that cases have been known where $500 have been paid for the right to ship goods which were barely worth $1,000."

In addition to this, a high rate of freight was paid, and King's dues of 10 per cent. were levied in Acapulco.

The merchants of Spain were systematically opposed to this trade, in which they had no part, alleging that the large import of Eastern stuffs into Mexico was prejudicial to the trade of the Peninsula, and, in consequence of their representations, the value of the cargo of the galleon from Manila to Mexico was at first ordered not to exceed $250,000, and the return cargo of silver, &c., not to exceed $500,000. In 1702, these were raised to $300,000 and $600,000, and, in 1734, to $500,000 and $1,000,000, but, of course, the real value of the cargoes much exceeded these figures.

How little effect such restrictions had may be judged from the following extract from a well-informed Spanish writer, which furnishes an interesting commentary on the little real power which upright officials under such an administration have to eradicate abuses :—"Those governors of the Philippines," he observes, "who have not had an eye to their own interests, but have obeyed strictly and zealously the orders from Madrid, have always been the victims of those whom they have opposed; while those who have winked at abuses, have allowed the galleons to be loaded in contravention to royal orders, and have devoted themselves to filling their own pockets, have generally had a better fate."

The financial facilities for the trade were provided largely by the Obras Pias, or societies for pious works, which served both as bankers and underwriters. They advanced money on the following terms: for a venture to Mexico 50 per cent., to India 35 per cent., to China 25 per cent. Their capital consisted of money left for charitable purposes by pious benefactors, with the proviso that it was to be employed in the foregoing manner, the half of the yearly profits being devoted to the charitable object, the other half being added to the capital. It is stated of one of these foundations, established in 1594, that between that date and 1730 it had given portions to 23,000 orphan girls, daughters of Spaniards, at an expense of $509,000; it had made a free gift to Government of $409,000, and expended in masses $156,000, and in alms $4,113,000, or a total of $5,187,000. As an example of what has been done in this way, I may tell you that a few years back a complete system of waterworks was erected, by which Manila is now supplied with fresh drinking water, brought from some eight miles distant; this was done, and is maintained, entirely out of the proceeds of a sum of money left some 200 years ago by a Spaniard, named Carriedo, to accumulate for this express purpose.

In spite of the restrictions upon the intercolonial trade, the Spanish merchants were not satisfied, their theory being that the silver which was shipped from Mexico to the Philippines (and which it was calculated had reached in 1789 the aggregate total of $350,000,000) was a dead loss to the Peninsula, and at last, in deference to their representation, it was decided to open direct trade between Spain and the islands.

The Government despatched the frigate *Buen Consejo* in 1766, with a cargo of Spanish goods, but the attempt was very ill received by the Manila merchants, who refused to give her any return cargo, and the little she took was loaded for account of the Government. Nevertheless they persisted in their plan, and despatched frigates regularly from Spain to Manila, and between 1766 and 1784, 14 voyages were made.

This latter year began a fresh era in the commerce of the Philippines. An interest had been aroused in Spain with regard to her distant colony, and a company was formed for the purpose of opening up the trade. It was called the Compañia de Filipinas, and received a charter from the Government, who gladly gave up their own mercantile ventures, the results having been uniformly unfavourable.

The interests of the Manila merchants were amply safeguarded in the charter, which, among other stipulations, prohibited the company from interfering with, or taking any part in the Acapulco trade. The new and more economical route was, however, too much for its older rival, and from this time the trade with Mexico gradually declined, till it ceased, as I have already said, in 1815.

The Compañia de Filipinas started with large but unpractical schemes for the development of the islands, spending enormous sums in trying to promote the cultivation of various articles of produce, especially spices, many of which could be grown better and more cheaply in the more southern islands. Thus they made large contracts for pepper at $\$13\frac{1}{2}$ per picul (140 English lbs.), while it could be bought in Sumatra for \$3 or \$4. In addition to this, and in spite of the fact that the number of the inhabitants was insufficient to cultivate all the available land, they wasted large sums of money in trying to turn the colony, which is essentially an agricultural one, into a manufacturing country, which should export piece-goods to Europe.

This mistaken policy was pursued for some twenty years, after which, having purchased their experience, as other Spanish companies have done since then, they abandoned their ambitious schemes, and adopted more rational commercial methods; but the company was never a success, and came to an end after some fifty years of existence.

In 1789, the Port of Manila was opened to vessels under foreign flags. In 1809, the first foreign firm, an English one, received permission to open in Manila, and, in 1814, this permission was made general; so that I have now brought down the commercial history of the islands to modern times. Up to this date they had really served as little else than an entrepôt for the exchange of goods between the East and West, the consumption of foreign goods in the islands being put down in 1810 as only of the value of \$900,000 and the exports of Philippine produce as only \$425,000.

From this time, however, with greater freedom of intercourse, and a more intelligent employment of capital, the great natural resources of the colony began to be developed, and the value of its exports, which are now exclusively its own production, amounts to some £5,500,000 a-year.

The value of the Philippine islands consists mainly in their immense agricultural resources, resources which, with more capital, a better system of registration of titles to property and its corollary, greater financial confidence might be very largely increased.

In process of time the mineral riches which undoubtedly exist will probably be developed: at present they contribute little or nothing. Coal is found in several districts, and is worked to a limited extent, but, owing to the absence of capital and modern engineering science, the results have hitherto been disappointing. Iron exists, but is only worked in the most primitive native fashion. So do gold and silver, but it is somewhat doubtful if they are to be found in paying quantities. Copper is worked by the natives to a small extent, but whatever may be the future value of these minerals, they may at present be left out of account. A considerable trade is carried on in timber, principally with China, the Philippine hard-woods being of most excellent quality, and many of them admirably suited for cabinet work.

In attempting, however, a short sketch of the present commercial value of the islands, I intend to confine myself to their agricultural products. These consist of sugar, hemp, tobacco, coffee, copra or dried cocoa-nut, sapanwood, and indigo (the two latter of small importance). I have no doubt most people think that tobacco is their principal, if not only, article of export. How often have I been met with the remark, "Manila—oh, that's where the cheroots come from;" but it will probably surprise most of you to learn that, with regard to cane-sugar, the Philippines are the third in importance of all the countries in the world. Their crop, some 250,000 tons, forms about 9 per cent. of the total supply of cane sugar, and in quantity

is only exceeded by Cuba, with some 900,000 tons, and Java, with about 430,000.

In Manila hemp they possess a unique product, which, so far, cannot be grown anywhere else, and the export of which is increasing by leaps and bounds, having risen from 38,300 tons in 1872 to 98,800 tons, valued at about £2,500,000, in 1892.

The trade in tobacco leaf is almost entirely with Spain, under contract with the Spanish Tobacco Regie, or farmed Government monopoly; and though cigars and cheroots are shipped almost all over the world, yet the trade in both leaf and manufactured tobacco is a speciality, and is not considered of much importance by the large export houses.

Agriculture is carried out almost entirely on the métayer or share system. The owner of the land provides the instruments, animals, machinery, and seed required. The "inquilino" provides the labour, and the produce is divided, in certain proportions, between these representatives of capital and labour. But in practice the latter rarely gets his fair share. He is generally in debt to the landlord for advances, subject to heavy interest; so that, when accounts are made up after the crop is got in, he generally finds that, instead of receiving anything in cash, he still has a debit balance against him to carry forward to the next year. The landlord usually suffers in the same way. He has rarely started on capital of his own, but on money advanced by local capitalists. The nominal rate of interest may, perhaps, not exceed $8 or $9 per cent., but if commissions on the sale of the crop, and on the purchase of supplies, &c., are added, he is frequently paying $14 or $15 per cent. for his money, and in these days of keen competition it is very hard to make any business pay which is so burdened. So long, however, as the registration of titles and mortgages is in so unsatisfactory a state, I see no remedy for this condition of affairs. Insufficiency of guarantee naturally leads to high interest, and, until the whole matter is taken in hand, and a radical change made, it cannot be expected that capital will be forthcoming on reasonable terms. This is unquestionably the crying want of the islands. With the judicious employment of capital, the production would enormously increase, and the quality of the products improve; but these are "Cosas de España" (Spanish matters), and I see no hope for a change.

The cultivation of sugar is practically confined to the following islands:—Luzon, Panay, Negros, and Cebu. Speaking in general terms, the first supplies what is known to commerce as Manila sugar, the second and third Iloilo sugar, and the last Cebu sugar, according to the ports from which it is shipped.

None of the sugar is of very high grade, owing to the practical non-existence of modern high-class sugar machinery; but the canes are very rich, and, with better appliances, the product might be made equal to any in the world, especially in the Iloilo district.

Each district produces what is called dry and wet sugar, the former being subdivided into various grades. The process of manufacture of the wet sugars is practically the same all through the Archipelago, but that of dry sugar differs in Luzon from that adopted in the southern islands or Visayas.

I will not go into the technicalities of manufacture, which would be wearisome, but will only briefly say that the Manila dry sugar is what is called clayed sugar, which means that, after the juice is cooked in open pans, the mass is poured into earthenware receptacles, or "pilones," shaped like an inverted cone. A thin layer of liquid mud is put on the top, the moisture from which gradually percolates through the mass, washing the molasses from the crystals, and carrying off the bulk of it through an aperture at the bottom into earthenware jars set underneath.

After standing for some weeks or months, the sugar is ready for further manipulation on the drying grounds, or "Farderias," which are entirely in the hands of the Chinese, who purchase the "pilones" from the planters. When they are opened, the sugar at the top is almost white, and gradually becomes darker towards the bottom. The white and dark sugar is mixed together in certain proportions, according to the grade which is to be produced. It is then spread out on mats to dry in the sun, for which one day is sufficient in dry hot weather. When dry, it is packed in mat bags and is ready for shipment.

I do not consider this system a good one. Excellent and trustworthy man of business, as I hold the Chinaman to be in most of his transactions, he is an inveterate adulterator, and the sugar, after passing through his hands, is not so satisfactory as it should be.

I much prefer the system ruling in the Visayas. Here, the juice is cooked to a very high point, almost all moisture being driven off. The mass is then poured on to large wooden trays, and stirred up, to allow the escape of any moisture which may remain.

It rapidly crystallises, after which it is at once packed in the usual mat bags, and suffers no further manipulation before shipment. Why this system is not adopted in Luzon, it would be hard to say. One theory is, that owing to the difference in the soil, the sugar which is produced there cannot be treated in the same way; but I should ascribe it to the inveterate conservatism of the natives, summed up in the expression, which covers such a multitude of anomalies in the Philippines, "Costumbre del Pais," the custom of the country.

Any of you who are acquainted with the modern improved forms of sugar manufacture which are employed in the West Indies and Java will see how far behind we are in this respect, and will be able to judge what the Philippines could do under better auspices if, even now, with the rude and inadequate means at their disposal, the planters are able to increase the cultivation, and make it pay, in competition with such formidable rivals.

I now come to the second in importance of our articles of export, known commercially as Manila hemp, though it is really not hemp at all, but is produced from a species of plantain, or banana tree, the scientific name of which is *Musa textilis*, and which differs little, if at all, in appearance from that which produces the edible banana. This valuable plant grows only in the Philippine Islands. Attempts have been made to introduce it into North Borneo, Cochin China, the Indian penal colony of the Andamans, and other places, but hitherto without success. It evidently owes its characteristics to some peculiar condition of soil and atmosphere, which are found in conjunction in the hemp districts of the Philippines, and nowhere else, so that they have up to now the monopoly—a natural, not an artificial monopoly—of this most valuable fibre. The plant flourishes best in hilly or mountainous districts; and, as it is found chiefly in the eastern parts of the islands, along the true volcanic line, it would appear that a volcanic soil, in conjunction with a moist, warm climate, due to the proximity of the Pacific, is especially suited for its development. Drought is its worst enemy. Granted a suitable site, its cultivation presents no difficulties, and may be said to be almost automatic. It is a perennial, not an annual crop. If you have seen plantain trees growing, you will know how the young shoots spring, month after month, from the parent root, so that on the same plant we have them of various ages; thus, after the plantation—locally called a "late"—is laid out, the plants go on reproducing themselves, and no more care is required than to keep the spaces between the plants fairly free from other growths, and to replace those which die from accident or old age. At the age of three years, the shoots attain their maturity, and they should be cut just before they bear their first fruit, as they then yield the fibre in its perfection. If cut too young, the fibre is apt to be weak and short; if too old, it is harsher and more brittle. On a well managed plantation work is begun at one end, the mature shoots are selected, cut down, and at once turned into fibre. The men, working in couples, gradually work their way to the other end. By the time that is reached, fresh shoots have matured on the plants which were first treated; and so the work goes on, year after year, and all the year through, for there is no fixed season.

You must understand that the plantations of any importance are of great extent, for the plants require considerable space for their development; and as a plant yields at each cutting rather less than one pound of fibre, it requires some 2,500 to produce a ton of hemp; these would occupy about six acres, for an acre only yields about 400 lbs. a year, and the production of a ton of hemp would employ two men on an average five or six months. The maximum which two first-class men can turn out in a working day is 25 lbs., so that, deducting Sundays and holidays, the time occupied in weeding, labour on their own patches of rice, or sweet potatoes, &c., the average product of two men's labour will be about as above.

The plantain is indigenous, and if the stem be cut across, it is seen to consist of a number of concentric layers, or petioles. The mode of preparation is to all appearance a very rude one, but no scientific machine has as yet been invented, though many have been tried, which can advantageously replace the native instrument. This consists of a portable wooden bench, to which is attached a knife blade, hinged at one end and connected at the other to a treadle, by which the pressure can be regulated. The layers of the plant are stripped off and drawn through two or three times between the knife and the bench. This removes all the sappy matter, and the clean fibre remains. It is then dried in the sun, and is ready for sale.

If properly prepared, the fibre is strong, clean and white; but a practice has sprung up in some districts, and is, I regret to say, spreading, of notching the blades of the knives in order

to facilitate the work. The layer naturally passes through more easily, but the resulting fibre is much coarser, and preserves an undue quantity of sappy matter, which discolours and weakens it. Another plan is, instead of at once working up the plant when cut, to leave it lying for some time, by which means it becomes softer and more easily worked, but the colour and texture are injured.

Of course, the exporter does not pay so good a price for this inferior fibre; but still the deductions he makes do not counterbalance the advantages which the producer derives from adopting these means, by which he obtains a greater weight of fibre from a given number of plants, and can work up a greater number in a given time.

Strong measures are sometimes taken by the local authorities to put a stop to these abuses, inferior hemp being sometimes seized, and burnt; but so long as the consumer in the United States and the United Kingdom continues to pay a correspondingly high price for the inferior fibre, no steps which may be taken by the exporters or local authorities can possibly attain their object. Sixteen or seventeen years ago, when I first knew the Philippines, these inferior grades of hemp were hardly known: now, I regret to say, they are in large supply.

Manila hemp is undoubtedly one of the finest fibres in the world, and the consumption is increasing very largely. Besides its employment for ordinary roping and cordage purposes, it is now extensively used for what is known as binder twine, the twine that is used in the harvesting machines for mechanically tying up the sheaves of grain as they are cut. For this purpose the only two really satisfactory fibres are Manila and Sisal, the latter produced in Yucatan from a species of aloe.

The Manila coffee crop has never been a large one, the maximum yearly export not having exceeded 6,000 or 7,000 tons, and I am sorry to say that the plantations have almost been destroyed by disease during the last few years, so that the crop has dwindled to something like 300 or 400 tons. How great a loss this has been to the producers in the coffee districts you will understand when I tell you that, since the year 1887, when the price advanced very materially, the ton of coffee has yielded the planter a profit of not far short of £30 to £35 a ton.

Copra has been added quite lately to our list of exports. It is, as you are perhaps aware, the dried kernel of the cocoanut, vast groves of which exist on all the Pacific coast of the islands. It is shipped principally to Marseilles and to Liverpool, where it is crushed into oil, largely used in the manufacture of soap. The exports last year amounted to 16,000 tons valued at about £160,000.

Rice is largely grown throughout the islands, but it is not exported, and does not even suffice for local consumption, to provide for which considerable quantities are imported from Saigon, Hong-Kong, and Bangkok. The native rice was formerly prepared by very rude means from the paddy, but one or two mills provided with all modern improvements in machinery have lately been erected, and are turning out a very fine quality of cleaned rice.

Until about twelve years ago the export of tobacco and the manufacture of cigars was a strict Government monopoly. In the southern islands the cultivation was free, as was the manufacture and sale of cigars, for strictly local consumption, but the manufactured leaf had to be sold to Government.

In Luzon, where most of the tobacco is grown, the conditions were much stricter. In the provinces of Cagayan and Isabela all land suitable for tobacco had to be devoted to that purpose, and the natives were forced to cultivate it. The leaf was classified by Government inspectors, and purchased by Government at a fixed price; and the abuses to which this gave rise can readily be understood. Nor was this all: ready cash was rarely available to pay for the leaf, and this was done by Government bonds, which were never worth their face value, and often sunk as low as 50 per cent. discount, at which they were purchased from the natives by unscrupulous speculators. So crying an evil had this become, and so large was the unpaid quantity of this Government paper, that, some years ago, the authorities announced that a certain number of bonds would be paid off every month by public tender, but in no case at a less discount than 20 per cent.

The cultivation and manufacture is now quite free, but the improvement in quantity and quality has not quite fulfilled the expectations which were formed of the results of this new departure.

DISCUSSION.

Mr. A. ROGERS asked what was the nature of the character in which the original native language, which appeared to have been lost, was written.

Mr. MacPherson said he believed that there were one or two specimens still extant, but he had not been able to connect them with any known character.

Mr. Rogers said that he had been interested by the reference to scraped oyster shells being used in the place of glass; these were also used in India, in Portuguese buildings. He fancied the Roman Catholicism must be rather of a bastard description. Outside a church not far from Bombay there was the glory and the monogram "I.H.S." This monogram was surrounded by very stiff sun-rays, and supported by what were supposed to be angels. These angels were men with shaven heads, brown cut-away coats, knee gaiters, sandals, and wings.

Mr. J. S. Dyason asked whether Mr. Mac Pherson could inform them whether there were any standard works upon the Philippine Islands. He understood from a friend who had been in that country that such works were very few in number.

Mr. MacPherson said that there were only a few English works, though there were a good many in Spanish.

Mr. Day inquired whether earthquakes had left any great traces behind them. He should also like to know whether volcanoes had caused destruction of property.

Mr. MacPherson replied that they had not left any permanent traces on the country.

The Chairman said that the subject on which Mr. MacPherson had been so good as to read a paper that evening was new to their Society, and they were glad to have so complete a statement from a gentleman so well qualified to write upon the Philippine Islands, it being a subject which had been treated in very few works that had been published in England. It was important for them to possess in the *Journal* so valuable a contribution to their knowledge of the Far East. He might supplement Mr. MacPherson's paper by a few statements taken from a recent French report on the Philippine Islands. This report was to the effect that trade had suffered by reason of Custom charges by the Spanish Government, that the quality of tobacco had recently improved, and that lately the cultivation of coffee had been on the increase. This fully confirmed Mr. MacPherson's view that the agricultural prospects of the island were good, particularly with regard to hemp. As Mr. MacPherson had told them, the country was not yet explored. Its minerals were, therefore, little known; but there was good reason to think that these resources would form in the future the means of large development, and also, he thought, the timber trade would admit of large extension. It was interesting to notice that a considerable trade seemed to be springing up between the Philipine Islands and Canada. All these developments of Colonial trade were matters of great interest to this country, and they always received attention at the hands of the members of the Society of Arts. The French document, to which he had referred, mentioned that considerable improvements had recently taken place in the town of Manila. The harbour was being enlarged, railway construction was advancing, and electric lighting had recently been introduced. If a more liberal system was adopted of granting titles to land, and so facilitating cultivation and mining, there could be no doubt that the development of the country would receive a rapid impetus. It was satisfactory to know that a very large proportion of the trade was English, and also that English shipping predominated in the ports of the Philippine Islands. He hoped that some gentleman present would add further remarks on the subject; and he was sure they would all join with him in expressing a very hearty vote of thanks to Mr. MacPherson for the very interesting paper which he had been so good as to read.

Mr. Dyason pointed out that there was one English work on the Philippine Islands which had been favourably received by the Geographical Society.

Mr. MacPherson said that there were two or three works, but the Philippine Islands had never been treated in the way they deserved by English writers.

Mr. J. Russell McLaren, speaking in the name of several gentlemen whom he saw present, closely connected with the commercial welfare of the Philippine Islands, said that they had all been extremely interested in the paper. Some remarks which had been made by Mr. MacPherson as to the agricultural prospects were very encouraging, as they appeared to forecast a large increase in the production of Manila hemp; but he should like to ask, having regard to the present position of hemp, and the low price of the article which would follow from increased production, whether there were any possible means which would allow the Spanish Government to artificially reduce the production of the article. If there were not any such means, he should be glad to hear the views of Mr. MacPherson as to the total possible production of the article in the islands, and the probable reduction in price, which would inevitably ensue; also as to what would be the minimum price at which the article would be produced to the fullest extent of which it was capable.

Mr. MacPherson said, with regard to the cultivation of hemp, that that was a matter of supply and demand to a certain extent. The cultivation could only be extended in the outlying districts when good prices were paid. If the price should go down some pounds a ton, the production would fall off. As it was, he thought the tendency of the production was to go on increasing moderately, and he hoped that the consumption would go on increasing likewise.

The vote of thanks was carried unanimously.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 26, 1893; FRANCIS COBB, Treasurer of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Capper, Prof. David Sing, M.A., King's College, Strand, W.C.
Fletcher, George, 59, Wilson-street, Derby.
Hatton, John Leigh Smeathman, M.A., People's Palace, Mile-end, E.
Ryder, Charles Foster, B.A., Gledhow-hill, Leeds.

The following candidates were balloted for and duly elected members of the Society:—

Barker, Frederic William, 6, Ferndale-road, Sefton-park, Liverpool.
Batten, George Henry Maxwell, 3, Ralston-street, Tedworth-square, S.W.
Martin, Major Gerald Ward, H.M. Assay-office, Mint, Bombay.
Rozario, Louis Charles do, Hong Kong.

The paper read was—

THE PICTORIAL MODIFICATION OF PHOTOGRAPHIC PERSPECTIVE.

By H. Van Der Weyde.

Ever since I invented my system of reflected electric light, which I had the privilege of exhibiting in this room many years ago, and put aside for a time my palette, to join the ranks of the photographic profession, I have been made to realise as acutely as anyone the limitations, impossibilities, and shortcomings of photography. Not only have I felt that these limited my ambition while I was trying unconventional posing, but it has often been painfully irksome to have to explain the restriction of my powers to a class of sitters whom I may fairly describe as the non-photographic type. These sitters—and most of them, I must confess, are of the fair sex—are prone to lament that their hands (which they always try to hide)—to say nothing of their heads and waists—come out much too large. Others, again, fancy themselves much taller and slimmer than they optically, or perhaps I may say architecturally, really are, and I have always been compelled to admit that they are right—that is to say, visually right, artistically right—and that photography in their case could not do justice to one's visual impression. The invention which it is my privilege to submit to your notice this evening is, therefore, the outcome of necessity, and meets a great want which all leading men in the profession, and many amateurs, have long and keenly felt.

On few subjects, I venture to submit, has there been of late so much discussion, so much debate, and so great a confusion of ideas as on that of the question of the truth of photography, and the value of its services to art, which latter have been most generously and freely admitted by the greatest masters of the brush amongst us. But now that we are attempting to correct figure, portrait, and landscape photography, I think the time has arrived when we may usefully attempt to analyse it, and appraise it at its actual value; the more especially as I am convinced, from careful observation of the work of some of the best draughtsmen and painters of to-day, that the close study of photography is ruining their judgment and vitiating their appreciation of the beautiful. Eloquent proofs of the baneful effects of the new creed, that photography cannot lie, appeal to us on every hand. Take up, for instance, the current number of the *Century Magazine*; here we find a draughtsman of the first rank permitting himself to draw horses in action as no other man has ever drawn them, and, as, I venture to add, no human eye has ever seen them. Obviously he has studied instantaneous photography, and honestly believes that he is taking a fearless and conscientious new departure in pictorial art in the cause of truth, oblivious of the fact that the camera registers a section of an action immeasurably more minute than the eye of a man can chronicle and convey to the brain, and, therefore, he depicts what he has never seen, depicts what is to all practical purposes an untruth, a state of affairs of which no human cognizance has or can be naturally taken. Similarly, we see portraits now-a-days painted under a like influence. Time was, about half a century ago, when artists, obeying the behests of fashion, painted heads, hands, and feet absurdly small. Photography, no doubt, is responsible for the reigning reaction. The tendency of town dwellers—the professional class, artisans, tradesmen, &c.—who get little exercise for their whole bodies, and use their heads and hands only in the struggle to earn a living, is to beget a large headed, small bodied race, while those who from early youth get plenty of exercise—the privileged classes, the aristocracy, the agricultural labourers, and even the miners—are noted for their more

symmetrical or classic proportions, and their well-poised small heads.

We see at the Royal Academy, the Salon, and elsewhere, portraits disfigured by enormous heads, hands, and feet, looking for all the world as though their outlines had been traced from an enlarged photograph originally taken with a short focus lens. We see figure-pieces intended to carry us back to classic times, which would be delightful and perfect but for something which takes away their ideality, which makes them too familiar, almost vulgar. What is this something? It is, that we instinctively recognise in the figures, the type of the modern town-bred model, or of the sedentary professional race, perhaps members of the artist's own family. It is not, however, given to every painter of classic subjects to so appreciate and adore that perfect harmony of a classic form as to be able to be true to, and resist the deterioration of, his ideal through the constant contemplation of his models, and the baneful influence of optically distorted photography.

Science protests that photography cannot lie. Well, optically it cannot. I have been trying to put my argument into a nutshell. I may not have succeeded, but here it is for what it is worth—optical truth is not visual truth. This may seem very much like a paradox, but the dictionaries are so singularly unaidful to me in my dilemma, that, for the sake of argument, we must let it stand for the present. The force of the statement is, however, one which the future must speedily recognise.

Optical truth, then, as far as photography is concerned, is the result of a mere mechanical impression on a plate, which is sometimes more wonderful and beautiful than anything the human hand could fashion; but which, on the other hand, is sometimes so brutal in its fidelity, and microscopically vulgar, as to give one a very disagreeable surprise.

Visual truth is a very subtle quality. Its appreciation depends on the observer's artistic sense and powers of comparison. I would go as far as to claim it as an hereditary quality which different people possess in different degrees.

There is a great distinction between it and optical truth, or the truth of the camera. The camera focusses every spot at the same instant, without favour or prejudice, uninfluenced by natural selection. The impression on the brain, on the contrary, is affected by all these things. The eye focusses only one portion of an object at a time, and whilst the rest of such an object is within the diffused vision, the impression on the brain depends on the temperament, and the more or less artistic environment of the observer; the brain instinctively and unconsciously recognises the quality of distance. In portraiture, we have to please the family, the relatives, and the friends of the subjects—those, in short, who are most familiar with their appearance; and, in their case, the visual truth is the outcome of loving and friendly contemplation. The first essential for a successful portrait painter is that he should be sympathetic, possess a great deal of the milk of human kindness, and love his fellow-man. These are the gifts that will enable him to approach his sitter in the family spirit. When he paints a portrait, say of a sweet old mother, he unconsciously tones down and modifies the optical truth, and, guided by the visual truth, he accentuates the air of distinction and spiritual dignity which his own refinement enables him to see and appreciate. But the photographer, though he be a born artist, and ever so appreciative of these qualities in his sitter, is cribbed, cabined, and confined within certain limitations and poses. It is almost useless for him to study the work of the great portrait painters, for the moment he copies an unconventional pose, say with hand or foot extended towards the camera, he produces a libel, and I defy any one to judge of the actual size in proportion to the body of the extremities of a sitter, when thus brought forward in a photograph.

It has been advanced by some that this distortion can be overcome by a long focus lens at a long distance; but, although it does partially reduce it, the conditions are unnatural, and the portrait loses that subtle yet powerful effect which makes one see the sitter in one's very presence, what one might call a "speaking likeness" effect, to obtain which it is essential that the point of sight, whether optical or visual, should have been within a conversational distance. A long distance immediately suggests a theatrical effect, unsuitable for the portraiture of private people. Whether this view is correct, or would only occur to one having the knowledge and practice of these distances or points of sight, is perhaps open to discussion.

I will now give you a number of pictorial illustrations by magic-lantern, showing the difference between optical and visual truth, produced without changing the lens in front of the camera or the distance from the sitter. I will also show you the wonderful possibilities

of this new power by a single humorous illustration, using a photograph of Mr. Marshall P. Wilder, that quaint American humourist, for my subject. I will also take a portrait by my light in an unconventional pose, and correct before you its inevitable distortion, and afterwards give you, as well as I can, a scientific explanation of my invention.

Before I had brought my invention to its present state of adaptability, I found I had to solve five problems.

1. To reduce locally the size of a head or hand, or other portion of a figure, and to do it symmetrically, so as not to change the character or symmetry of a head or the expression of a face ; or, in the reduction of a hand or waist, to reduce, if desirable, the width only, and thus give a slender instead of diminutive effect.

2. Having solved this first problem—how to find a way to make a number of corrections in one negative at the same time, and with such simplicity and rapidity as not to call for special skill or training, or materially lengthen the time usually occupied in focussing during adjustment.

3. To shorten or to lengthen a portion of the whole negative right across without distorting the rest, such as lengthening the waist or skirt of a lady's dress, or, in the case of a landscape, to vertically enlarge the middle distance or horizon while reducing the depth of foreground and sky.

4. To obtain with each lens a variable degree of the modification of the dimensions of the parts corrected, so as to avoid the necessity of employing a great number of lenses to form a working set.

5. To find a readily-fashioned refracting medium, so as to enable one to make at will eccentric alterations, or even distortions, especially suitable for the purposes of caricature.

The first problem I solved by the interposition in front of the sensitive plate of a supplementary lens. Although I claim this interposition as part of my invention, the abrupt ending of the curve of an ordinary lens would not only throw a shadow or dark zone upon the negative, but the abruptly broken-off lines and shades on the outside of the zone would not tally with those on the inside. I, therefore (and this is the germ of my invention), continually vary the curvature of my lens until it reaches the plane—in other words, where the circumference of a plano-convex lens would otherwise stop—it flows or graduates into the reverse or concave curve or, if plano-concave, *vice versa*, and thus gradually merges by a wave-like line into the plane, with the result that the dark zone before referred to, consequent on the use of an ordinary lens, is replaced by a perfectly natural gradation, leaving no evidence whatever of the correction having been made.

The second problem I solve by providing a number of small lenses, each constructed on the above-described principle, and means of invisibly and adjustably supporting them in the pencil of rays.

In problem 3, to enlarge a portion only, such as the distance of a landscape, or to lengthen portions such, as the skirt of a figure, I interpose a plate of glass, a portion only of which is of a cylindrical form, flowing gradually into a plane.

I solve the fourth by so arranging these lenses in the camera as to be readily moved backwards and forwards, thus varying the amount of the reduction of any part by change of focus. About a dozen corrector lenses will thus be all that are required to form a working set for ordinary portraiture.

To solve the last problem, I have found a readily-fashioned refracting medium, but as it requires considerable artistic skill to use it, and there are many difficulties to be overcome in its practical use, I am not in a position yet to bring it to your notice. It is embodied, however, in my patents.

It is easily seen that to use these corrector lenses requires no special training ; only an eye for natural or visual proportions. That it is readily abused and dangerous in the hands of the stupid and ignorant only proves its wonderful pliability and adaptability in the hands of an artist, and instead of there being any drawbacks to its use, such as an increased time for exposure of the plate, on account of passing through more glass, the fact that the rays of the image are converged upon the parts rectified increases the brilliancy of the image, and it is found that the time of exposure is actually decreased.

This new power has many possibilities which you can readily imagine. I prefer at present to hide from you other evidences of its versatility in the domain of caricature, wishing only to advance the cause of that which is the more beautiful and true. In this I have been encouraged by Sir Frederick Leighton, than whom we have no greater exponent of the beautiful in form, and who, on a recent occasion, when visiting my studios, to investigate this invention, expressed, not only his surprise,

but his delight at the startling artistic gain, and the consequent visual veracity of the images I am enabled to produce.

Experts in optics are apt to have no sympathy or ear for the claims of art, and some will doubtless declare that optical truth is the only truth, and any correction a distortion. I was, therefore, doubly pleased, when I brought this invention before the Camera Club the other evening, to receive the congratulations and praise of its President, Captain Abney, the most advanced scientific expert in photography of the day. Unfortunately, he is prevented from being here this evening by an accident.

Hereafter, we shall be able to make pictures which will not only tell us the visual truth, the real truth to our minds and hearts, but also tell us something of the individuality of the photographer, thus raising one branch of photography another step towards becoming a fine art.

In conclusion, I would point to the examples I have shown you, and ask if they do not furnish an irrefutable proof of my assertion that optical truth is not visual truth.

DISCUSSION.

The CHAIRMAN said that, in listening to Mr. Van der Weyde and seeing his results, and especially in seeing how he put his lenses on the plate of glass, one was forcibly reminded of Columbus and the egg, and wondered that no one had thought of it before; but all strokes of genius came out in that way, and the greatest simplicity often displayed the greatest genius. He was very glad that a landscape photograph had been included among the lantern slides; because he had no doubt that many present had seen Vicat Cole's "Royal Windsor," and no photographer could ever take Royal Windsor like that. He had looked at the place itself, and tried to imagine where one could get a view of itlike that, and he was quite sure that the painter had etherealised it, and produced a picture which no camera could give. There had been, in fact, an alteration of the middle distance, and that the camera was powerless to do, unless with the aid of some such device as had been described, which he thought was destined to ally landscape photography more nearly to art than ever it had been before.

Mr. TRAILL TAYLOR said that they all knew Mr. Van der Weyde's great abilities, and must acknowledge the exceedingly successful way in which he had sophisticated these portraits. It was not a subject for a scientist, but for an artist; for an artist did not care whether a picture was truthful or not.

Mr. W. E. DEBENHAM said that it was not necessa to say how much they were all interested in seeing the results, but those who felt as he did must prote against it being asserted that the instrument used wa an optical corrector; it was, as had been said, sophisticator, and he protested strongly against th expression that optical truth was not visual trut and maintained that images obtained in this way we not visually true. The two expressions, optica truth and visual truth, were, in fact, interchangeabl There were three objects in using an arrangement c this kind, one being to change the character of th perspective. Now, photographic perspective wa simply a representation of objects larger in proportio as they were nearer; in fact, as they appeared to th eye. If one stood near a long building, and looke at it sideways, the near wall might appear half a high again as the wall at the other end; but no on would call it a distortion to represent it so, and eve painter would so paint it, just as it was seen, and a a photograph would give it. If they saw trees in th foreground, and in the middle distance, a near tre might appear perhaps three times as high as tree in the middle distance; the artist recognise that, and it was so accepted. But in representin single-figure pictures, artists had not been in th habit of representing the advanced portion of figure larger in proportion Now pictures appeare to be for the most part judged, not by the beholder' knowledge, and by comparison with the original sub ject, but by comparison with other pictorial repre sentations of similar subjects to which he was accus tomed. A Chinaman was perfectly satisfied to se objects which he knew to be of one size represente of one size, although at different distances; they wer accustomed, in buildings and in a general sense, t see nearer objects represented larger than mor distant ones, but they were not accustomed to se single figures painted in that manner, and, therefore when a photograph showed a protruding han larger, and one in the opposite direction smaller, i was said that photography distorted. It was sai that a man's boots were not twice as large as hi head, and so on. Of course, it would be an extraordinary position for a photographer to choose and no artist would choose such a pose, but if it were adopted, the true representation would be exactly as the photograph gave it. However, as people were not thoroughly accustomed to perspective in single figure pictures, there was something to be said in favour of a sophistication to this extent, which brought the picture more in accordance with wha they were accustomed to. The second point was that this contrivance enabled the photographer to make pictures more in accordance with the conventional ideal. It was said that sitters complained that their waists and heads were too large; he was not now speaking of perspective effects, when one portion of the body was nearer the camera, but of waists and heads generally being too large. Too large for what? Simply for the conventional ideal, according

to which they had been accustomed to see them painted, which, as Mr. Van der Weyde had told them, was considerably too small. Photography had, to a great extent, cured painters of that fault, and there had always been some too great and too genuine to pander to fancy and fashion in that way; but at all events it was very common to paint heads and waists too small, and hands also; and an arrangement of this kind enabled the photographer to satisfy those who wanted rather a conventional ideal than a truthful representation. Again, it was said that mountains appeared too small and insignificant; that, being objects of interest, they filled the mind and gave the idea of being larger than they actually were. But if that were so, why should waists and heads, which were not objects without interest, be made smaller? In both cases it was simply a question of what would be most effective or pretty, not what was most in accordance with truth. Painters had been in the habit of flattering, it paid them to do so, and no doubt many sitters would be better pleased. If this plan enabled photographers to flatter vain women by making their heads and waists appear smaller than they were, no doubt it would be commercially successful, but do not let them lose their self-respect by flattering their sitters, in word as well as action; telling them that these smaller heads or waists were in accordance with optical, or visual, or any other truth, when it was simply in accordance with a conventional ideal. Optical and visual truth were essentially one.

Professor C. Roberts-Austen, C.B., F.R.S., said that he had no knowledge of photography, but he did not like to let a paper of such extraordinary interest pass without a word. It seemed to him that the author had guarded himself against any charge of inaccuracy by saying that optical truth, as far as photography was concerned, was a merely mechanical operation. It had been known for a long time that our impressions were not to be trusted—that seeing was not believing—nor could they believe altogether what they only felt. If they crossed their fingers and rubbed their nose, they would feel quite certain they had two noses; and a sophisticator, if it was to be called so, was, in such cases, absolutely necessary. His wife happened to be an artist, and he had heard her say, with reference to a figure, that it was not high enough, that it ought to be eight heads high, or whatever the number was. He did not like to think that what they had heard was mere sophistication. It seemed to him that the author had shown how, by taking thought, they might add cubits to their stature.

Mr. T. R. Dallmeyer said that it appeared to him that one of the remarks in the paper was a mere truism, viz., that photographic perspective and visual perspective were not the same. Photographic or optical perspective was a science, but the way in which they saw things was dependent on psychology, which was not a science, and he did not believe it ever would be. Although photographic perspective was a science, it did not correspond with what they saw in the physiological sense. He had been much interested in these experiments, though it could not be called anything but a clever device. The only case in which photographic perspective and psychology agreed were when the images were entirely on one plane: then they were identical. They knew that the best results in photography were when the whole image was as far as possible on one plane. Before this device (which would doubtless be largely employed for portraiture), it appeared to him that a man exercised his skill as a photographer in arranging the sitter in one plane wherever it was possible, and cases in which the feet or hands came forward were the exception. He was not an artist, but, from an artist's point of view, he should think that this flattering device was an exceedingly useful one, and would probably become very popular; but it was not at all true. He must insist on that, because he thought Mr. Van der Weyde rather misunderstood Captain Abney the other day. He welcomed, as they all did, any scientific application of an optical nature, but he felt quite certain that he did not mean to convey that the results thus obtained were of an order which could be classed as scientific. As to landscape, the only example shown was one copied from another photograph, a portion of which might be lengthened, or exaggerated, according to the psychological view of the individual, and it certainly looked very much better; but he did not see how this method would work in actual practice. If they took the case of a tree cutting the horizon, and applied this method to it, the middle of the tree would bulge out. There were only certain subjects on which the process could be used, and it appeared to him that an immense number of these correctors would be required to produce the desired effect in a landscape.

Mr. Van der Weyde said that there were two reasons why this method was valuable; one, because it enabled them to give a better suggestion of true proportion than an ordinary photograph would, if one part of the object came forward; and that was a solid, artistic reason. The other was that it enabled them to please their sitters. But these two reasons should not be mixed up. There was no reason to decry the whole thing because it might be abused. He remembered very well, in early youth, when looking at photographs of people he knew well, that it always struck him how large their heads looked. The impression generally conveyed was not that conveyed by the photograph, and he contended that as a rule the head should be slightly diminished in order to give the natural impression. In taking a lady playing a violin, it was very difficult to avoid distortion, and an unnatural pose had to be adopted.

The Chairman said that they would all agree that

they were indebted to Mr. Van der Weyde for one of the most interesting papers they had had on the subject of photography. With regard to visual truth, he had long had very great doubts whether there was such a thing at all. He was quite certain that if he and Mr. Van der Weyde both looked at the clock at the end of the room they would receive very different impressions: his short sight would only enable him to see a blur, where his friend would see the face distinctly. Visual truth, therefore, was a thing that no artist could attempt to arrive at. In the work to which he referred before, there was no visual truth at all; it was a purely artistic work from beginning to end. He concluded by proposing a hearty vote of thanks to Mr. Van der Weyde.

The vote of thanks having been carried.

Mr. VAN DER WEYDE, in acknowledging it, said that he agreed with much that Mr. Dallmeyer had said, but he could not agree with much that Mr. Debenham had advanced, and he thought that gentleman had ignored portions of the paper which he (the speaker) considered were conclusive as to the necessity for an instrument of this kind. A picture should always give a suggestion of the impression on the brain, and if it did not do that it was not a picture, but merely an optically true photograph. This instrument helped one to do more, to make an optical representation of it; it gave a better suggestion of what they had seen than had hitherto been possible, especially in the case of portions of the figure which came forward.

Miscellaneous.

PRODUCTION OF MICA IN THE UNITED STATES.

The name mica is not that of a single mineral, but is a family cognomen which embraces a number of varieties, all of which shine and split into more or less transparent sheets, highly elastic, and having certain ingredients in common. In addition to the importance of micas as rock constituents, their transparency, elasticity, lustre, comparative infusibility and electrical non-conducting power give them a number of applications in the arts and make them the object of industrial mining. The mica of the market is in nearly all cases the common white mica or muscovite. Although mica is so widely distributed in nature, it is only in a few localities, and when fissures in the rock have been filled with very coarsely crystallised granite, that mica can be mined with profit. According to a recent United States mining report, such fissure veins occur in a number of localities, notably in Siberia and Norway, and in the United States principally in New Hampshire, North Carolina, Wyoming, New Mexico, the Black Hills of Dakota, and probably in paying quantities in Alaska. All these mines are more or less alike so far as their natural features are concerned. The chief differences are artifical, and consist in the methods of mining and handling the mica. The mines of Western North Carolina have been largely worked and may well serve as a tyye. In travelling across the State to the westward, three distinct belts of country are met with; the lowlands, covered by recent alluvial deposits; the middle or Piedmont section, a low plateau, underlaid by older sandstones and shales; and last of all, the western or mountain section, in which the Appalachian system reaches its development. Many of the veins of mica occur in a fine-grained black gneiss, which passes with the mountain miners under the name of slate. The veins vary in thickness from less than an inch to ten or twelve feet, occasionally to as much as 30 or 40 feet; but these instances are rare. The mica is seldom prepared for market at the mine itself, but is taken to a neighbouring factory, and here the mica is put into shape for shipment. The blocks vary greatly in size; one from the Wiseman mine is reported to have been six feet long by three feet wide. Pieces a yard in diameter have been obtained at the Ray mine, in Yancey County, and similarly large plates have been found in Siberia: but these are exceptional. The average block is little larger than the page of a magazine, and is generally less than six inches in thickness. It separates very readily into sheets parallel to the base of the prism. It is estimated that this cleavage may be carried so far that it would take 300,000 of the mica plates to make an inch. The mica is generally split into plates varying from about 1-8th to 1-64th of an inch in thickness. In preparing these plates for market the first step is to cut them into suitable sizes. Women are frequently employed in this work, and do it as well, if not better, than the men. The cutter sits on a special bench, which is provided with a huge pair of shears, one leg of which is firmly fixed to the bench itself, while the movable leg is within convenient grasp. The patterns, according to which the mica is cut, are arranged in a case near at hand. They are made of tin, wood, or pasteboard, according to the preference of the establishment. Generally, they are simple rectangles, varying in size from about four to eighty square inches. The cutter selects the pattern which will cut to the best advantage, lays it on the sheet of mica, and then, holding the two firmly together, trims off the edges of the mica to make it correspond with the pattern. The cleaning process comes next. The cleaner sits directly in front of a window, and must examine each sheet of cut mica by holding it up between her eyes and the light. If there be any imperfections, and such nearly always exist, they must be removed by stripping off the offending layers of mica until a clear sheet remains. Finally, the cut and cleaned mica is put up in pound packages, and is ready for the market. There is an enormous

waste in the processes of preparation. One hundred pounds of block mica will scarcely yield more than about fifteen pounds of cut mica, and sometimes it is even less. The chief use of the cut mica is in stoves. In Siberia the sheets of mica are still sometimes used in windows. The sheets are also used in the peep-holes of smelting furnaces, in lanterns, in shades, and in the port-holes on board vessels, where the vibrations would soon demolish less elastic glass. Mica is an excellent non-conductor, and of recent years has been cut to some extent into narrow strips for use in the construction of dynamos. The scrap mica was formerly thrown away, with the exception of a small quantity used as a lubricating material, but it has recently found a market in several new directions. Old waste heaps in the United States are now being bought up for a few dollars a ton, and their contents cleaned by being passed through a rough mill. This is simply a roasting cylinder of coarse wire screen with its axis slightly inclined to the horizontal. The scrap is fed into the upper end of the cylinder and slowly discharges itself from the lower end. As it makes its way from end to end, the sand and dirt are supposed to fall through the meshes of the screen. The clean scrap is then ground into a coarse powder and distributed to the various industries requiring it. Large quantities are used in the manufacture of wall-paper. Considerable amounts are used to produce the snow effects on Christmas cards, and in stage scenery and other tinsel, while smaller packages under the name of diamond dust are sold as powder for the hair.

Correspondence.

FISHING IN NEWFOUNDLAND.

Referring to Mr. Cecil Fane's interesting paper upon Newfoundland, it is stated that the officers of H.M.S. *Emerald* killed nearly 200 salmon in three days' fishing, and that a friend of his killed 120 trout from ¾ lbs. to 5 lbs. in an evening and a morning's fishing. These statements are so very extraordinary to an angler of lifelong experience, that unless they can be thoroughly vouched I should feel disposed to consign them to the category of fisherman's tales. Again, I may add, that the reports from time to time in the *Field* concerning Newfoundland angling are anything but encouraging as compared with Labrador and the north coast of the St. Lawrence.

W. A. ADAMS.

Gaines, Worcester, April 12th.

With reference to the above Mr. Cecil Fane writes:—I notice that Mr. Adams first takes exception to my statement that the officers of H.M.S. *Emerald* killed nearly 200 salmon in three days' "fishing." Before writing this letter, I communicated with Sir. Baldwin Walker, Bart., R.N., late captain of H.M.S. *Emerald*, who has given me his authority to state the following facts with reference to this matter:—

"The *Emerald* anchored in Hare Bay, just north of Notre Dame Bay, at 5 p.m. on the 27th July, 1892, and only remained there until 4 a.m. on the 31st July; but all hands, officers included, were on board by 6 p.m. on the 30th July. It took an hour to get from the ship to the nearest pools in the river, and 208 fish were taken altogether. They were a mixed lot of salmon and grilse, the largest fish being 17 lbs. weight. The captain and two other officers camped out higher up the river than the others, and did not commence fishing until 3 p.m. on the 28th July, leaving their camp at 2.30 p.m. on the 30th; during this time these 3 rods took 96 fish."

In reference to the above facts, I may further state that the salmon frequenting the Newfoundland rivers run very small, and I believe that the largest fish ever taken with a fly weighed 25 lbs.

With regard to my statement that a friend of mine killed 120 trout in a morning and evening's fishing, I can unfortunately give no further particulars, as this gentleman is at present in Canada, and I have not his authority for mentioning his name, but I can personally vouch for his statement, which is not a "fisherman's tale," but a plain unvarnished fact. I was not present on the occasion, but I have seen a photograph of the trout taken, and also the record of their weights.

I trust that Mr. Adams will now be convinced that in recording these instances of fishing in Newfoundland, I have not been "drawing the long bow."

MANUFACTURE OF WHITE-LEAD.

It is unfortunate that while much is heard of the introduction of new methods of producing many things, so little is ever known of the causes of their subsequent failure.

I was for some time with the company working Mr. Martin's process, after he had severed his connection.

It is certainly better, because it should be cheaper, to act direct upon metallic lead for the preparation of the basic acetate solution. Mr. Martin's arrangement for producing the flaked lead was very ingenious, but on his racks the uppermost flakes formed a thatch preventing the solution acting upon the mass beneath, while the carbonic acid present in considerable amount (escaping from the precipitating vats) in the air necessary for oxidation converted the flakes into white-lead as they lay, and the process simply stopped itself. Even without the interference of carbonic acid, such an arrangement was impracticable.

When I first went to the works, revolving dissolvers were being tried, but though when first started one

was capable of causing the oxidation and solution of 500 lbs. of lead in twenty minutes from a charge of about 5 tons, the rotary motion rolled the lead into balls, when all action practically ceased. Curiously, these balls, many of which weighed several pounds each, were as solid as though cast, the solution having so cleaned the surfaces, that perfect welding was possible.

To utilise the plant, the use of litharge was introduced, and the manufacture of lead became a reality instead of a pious belief. The basic acetate solution, whether prepared from litharge or by the co-incident oxidation and solution of metallic lead, is chemically and physically identical, absolutely.

The theoretical composition of white-lead, 2 equivalents of carbonate to 1 equivalent of hydrate, gives a per-centage of 68·9 carbonate, 31·1 hydrate. The white-lead prepared by precipitation more nearly approaches this than any other stack-lead I have ever examined. It varies from 30 per cent. hydrate to 33 per cent., averaging about 31·5, while I have never found more than 29 per cent. hydrate in a stack-lead, and the average is about 26 per cent., and one sample by a well-known maker was only 18 per cent.

A precipitated lead "made in Germany" contained only 11·35 per cent. hydrate. In some cases precipitated lead high in hydrate contains it partly as a lower compound, probably 2 PbO, H_2O.

Mr. Martin's plan mentioned by Mr. Nursey for gaining density by the introduction of a homœopathic dose (0·10 per cent. more or less) of separately prepared hydrate to a white-lead already containing over 30 per cent. is purely fallacious. The gain in density was entirely owing to mechanicul causes relating to its treatment after precipitation.

Mr. Nursey draws a very harrowing picture of the ordinary white-lead works, "white cemeteries," the proprietors themselves, I suppose, a sort of "whited sepulchres;" but really I do not think they are so bad. Many of them have spent considerable sums in seeking for a method which would be free from the evils of the present one. With regard to sulphate of lead, Messrs. Cookson and Co., of Newcastle, some twelve or fourteen years ago, attempted to introduce it. While it is unlikely ever to displace the basic carbonate entirely, there is abundant room for its use. I certainly agree with Mr. Hannay as to the unwisdom of mixing hydrate of lead with it. If in homœopathic dose, it is useless, while in larger amount it annihilates the claim for it being non-poisonous, either in use or manufacture, and makes it as easily discoloured by sulphur compounds as the ordinary white-lead, while the sulphate itself is very slightly effected.

Norwich. T. Crisp Sanderson.

HISTORY AND DEVELOPMENT OF PATTERN DESIGNING IN TEXTILES.

With reference to the discussion on Professor Schulze's paper, printed in last week's *Journal*, Mr. J. E. Greaves writes from Rochdale to express thanks to those speakers who defended the Science and Art Department. Mr. Greaves writes:—"The Science and Art Department has been the only effective and practical means of bringing science and art within reach of the commonest artisans in the country. Its greatest needs have always been the want of more ample funds to supply the national demands." He hopes that England will wake up to a determination that the advantages of the department shall not be centralized for the benefit of a few, but be even more widely distributed throughout the kingdom. He also insists upon the necessity of County Councils and other local authorities charged with the administration of large funds acting for the good of the whole people, and with a knowledge of their actual requirements.

Obituary.

The Earl of Derby, K.G.—By the lamented death, on Friday, April 21st, of this eminent statesman, the Society loses one of its oldest and most valued members. He had been a life member since 1853, and was a vice-president from 1856 to 1861. When, in 1872, Mr. G. C. T. Bartley, now member of Parliament for North Islington, contributed to the Society a paper on "Individual Providence for Old Age as a National Question," Lord Derby presided, and made a speech so instructive and suggestive that it will bear careful perusal in connection with the present movement for establishing a system of pensions for the aged poor. Born in July, 1826, he was educated at Rugby under Arnold, and at Cambridge, where, as a student of Trinity College, he gave promise of his future success in life. He obtained a first-class in the classical tripos, and also took honours in mathematics. From 1848 to 1869, when he succeeded his still more celebrated father, the fourteenth Earl of Derby, he represented the borough of King's Lynn. He entered upon a long and eventful Ministerial career at the exceptionally early age of 26, his first office under the Crown being the not unimportant one of Under Secretary of the Colonies. Subsequently Palmerston, anxious to secure his support, placed the Colonial Secretaryship at his disposal. The offer, though declined, was a great compliment to the ability of a man not yet forty. As a member of his father's second Cabinet, Lord Stanley, as he was then, had charge of the Bill transferring the government of India from the Company to the Queen, and the manner in which he piloted that historic measure through the House of Commons greatly increased his reputation. At a later period he twice filled the post of Secretary of State for Foreign Affairs, and more recently he was Secretary of State for the Colonies, a position he had

occupied for a short time in earlier years. He was much sought after for Royal Commissions, where his practical knowledge, sound sense and clear judgment were of considerable advantage to the State. He served as a member of the Royal Commission on Army Purchase (1856-7); of the Cambridge University Commission (1856-60), and of the Commission of the Organisation of the Indian Army (1858-9). He was chairman of the Commission on the Sanitary State of the Indian Army (1859-61); of the Commission on Patents (1863-4); of the Commission on City Guilds (1881-2); and of the Commission on Market Rights and Tolls (1888-90). Lord Derby was distinguished among politicians for the genuine interest he displayed in social questions, and this interest with him was not a thing of yesterday. The Society's *Journal* (vol.. xx.) contains a full report of a speech delivered by him in 1871, at a public meeting held in Liverpool, for the purpose of forming a company to improve the dwellings of the working-classes of that city. In the course of his remarks, he estimated that the annual death-rate in Liverpool at the time was 10 per thousand in excess of what it need be. The causes he described as few and simple—over-crowding, drunkenness and immorality, together with, in certain cases, insufficiency of wholesome food. He was a firm believer in co-operation for the working-classes, and once declared that subject to be "more important, as regards the future of England, than nine-tenths of those discussed in Parliament." To the philanthropist, Lord Shaftesbury, he wrote:—"We are both public men, deeply interested in the condition of the working-classes; and for my own part I would rather look back on services such as you have performed for that class than receive the highest honours in the employment of the State." Not a few scientific or academic distinctions fell to his lot. Among the former may be mentioned his Fellowship of the Royal Society. His *alma mater* made him an LL.D., and Oxford gave him her degree of D.C.L. He was installed Lord Rector of Glasgow University in 1869, and Lord Rector of Edinburgh University in 1875. He suceeeded the late Earl Granville as Chancellor of the University of London. Though he never attempted anything so elaborate as his gifted predecessor's translation of Homer's "Iliad," he was not destitute of literary skill. Among the pamphlets he wrote was one on the "Overland Route to the Pacific," and another on "Church Rates." He also published, as a young man, a readable *brochure* entitled "Six Weeks in South America." Of late he had withdrawn very largely from active politics. In many other spheres he will be much missed.

General Notes.

Australasian Association for the Advancement of Science.—The next meeting of this Association will be held in Adelaide, South Australia, commencing on September 25th. The organisers hope that some of the members of the Society of Arts may make the meeting a reason for visiting Australia, or that those who have already the intention of taking a trip to the Antipodes will arrange to be in Adelaide at the time. The Association has been in existence since 1888, and now numbers about 900 members. The work is divided into sections as in the British Association, whose rules on most points have been closely followed. The meeting will be presided over by Professor Ralph Tate, of the Adelaide University, and the presidents of sections are as follows:—Section A.—Astronomy, Mathematics, and Physics: H. C. Russell, C.M.G., F.R.S., Government Astronomer of New South Wales. Section B.—Chemistry: C. N. Hake, Chief Inspector of Explosives, Victoria. Section C.—Geology and Mineralogy: Sir James Hector, K.C.M.G., M.D., F.R.S., Director of the Geological Survey of New Zealand. Section D.—Biology: C. W. De Vis, Curator of the Brisbane Museum. Section E.—Geography: A. C. Macdonald, Hon. Secretary of the Victorian Branch of the Royal Geographical Society of Australasia. Section F.—Ethnology and Anthropology: Rev. S. Ella, New South Wales. Section G.—Economic Science and Agriculture: H. C. L. Anderson, M.A., Director of Agriculture, New South Wales. Section H.—Engineering and Architecture: J. R. Scott, Lecturer-in-Charge of the School of Engineering, Canterbury College, Christchurch, New Zealand. Section I.—Sanitary Science and Hygiene: A. Mault, Secretary to the Central Board of Health, Tasmania. Section J.—Mental Science and Education: Henry Laurie, LL.D., Professor of Mental and Moral Philosophy at the Melbourne University. A circular received from the General Honorary Secretaries says:—"At the time fixed for the meeting, South Australia will be at its best. There is no better time at which to visit Australia than when spring is merging into summer. To naturalists, this time of the year is specially attractive, and these may be reminded that at the meeting of the Association they will come in contact with men of like tastes from all parts of Australia." Further information can be obtained from the General Hon. Secretaries, Professor A. Liversidge, F.R.S., Sydney; Professor E. H. Rennie, Adelaide; and Professor W. H. Bragg, Adelaide.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock:—

May 3.—Prof. Silvanus P. Thompson, F.R.S., "Practical Electrical Problems at Chicago." W. H. Preece, F.R.S., will preside.

Foreign and Colonial Section.

Tuesday evenings at Eight o'clock:—

May 2.—E. Delmar Morgan, "Russian Industrial Art." J. Hungerford Pollen will preside.

May 16.—W. B. Perceval, Agent-General for New Zealand, "Aspects of Federation."

Applied Art Section.

Tuesday evenings, at Eight o'clock:—

May 9. — Prof. W. M. Flinders Petrie, "Primitive Art in Egypt." Edward J. Poynter, R.A., will preside.

May 30.—James Dallas, "Devonshire Pottery." C. M. Kennedy, C.B., will preside.

Cantor Lectures.

Monday evenings, at Eight o'clock:—

Lewis Foreman Day, "Some Masters of Ornament." Four Lectures.

Lecture IV.—May 1.—The French styles—Louis XIV., Louis XV. and the Rococo—Louis XVI. and the revival of Classicism, and the Empire—With illustrations of the works of Le Pautre, Le Brun, Jean Vauquer, Jean Berain, D. Marot, A. C. Boulle, Claude Gillot, Watteau, G. M. Oppenort, F. de Cuvilliés, J. A. Meissonier, Cauvet, Gouthiére, C. P. Marillier, La Londe, Salembier, Passarini, and others.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 1 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Lewis F. Day, "Some Masters of Ornament." (Lecture IV.)

Farmer's Club, Salisbury-square Hotel, Fleet-street, E.C., 4 p.m. Mr. R. E. Turnbull, "Tne best way for Landowners and Tenant Farmers to meet the Present Times and Fall in Prices."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Dr. P. Dvorkovitch, "The Gassification of Coal and of Liquid Hydro-Carbons." 2. Mr. W. P. Dreaper, "Estimation of Tannic and Gallic Acids."

British Architects, 9, Conduit-street, W., 8 p.m. Annual Meeting.

Medical, 11, Chandos-street, W., 8½ p.m.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Mr. Maspers, "Egyptian Conquests in Syria."

Tuesday, May 2 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. E. Delmar Morgan, "Russian Industrial Art."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. R. K. Douglas, "Modern Society in China."

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Messrs. M. B. Jamieson, and John Howell, "Mining and Ore-Treatment at Broken-hill, New South Wales."

Pathological, 20, Hanover-square, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. P. L. Sclater, "Further Notes on the Monkeys of the Genus *Cercopithecus*." 2. Mr. M. F. Woodward, "Contributions to the Study of Mammalian Dentition.—Part I. Macropodidæ." 3. Mr. F. E. Beddard, "The Atrium and Prostat of the Oligochætous Worms."

Wednesday, May 3...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Silvanus P. Thompson, "Practical Electrical Problems at Chicago."

United Service Institute, Whitehall-yard, S.W., 3 p.m. Mr. Harry Williams, "How best to secure Continuity in the Effective Service of Modern Ships of War for Successive Commissions."

Archæological Association, 32, Sackville-street, W., 8 p.m.

Patent Agents, 19, Southampton-buildings, W.C., 7½ p.m. 1. Discussion of Mr. Clark's and Mr. Woosnam's papers. 2. Mr. E. Carpmael, "Preliminary Examination into Novelty." 3. Mr. John Hayes, "Section 103 of the Patents, Designs, and Trade Marks Act, 1883."

Obstetrical, 20, Hanover-square, W., 8 p.m.

Archæological Institution, Oxford-mansion, Oxford-street, W.C., 4 p.m.

Thursday, May 4...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Mr. Alfred Sanders, "Nervous System of Myseine Glutinosa." 2. Mr. W. B. Hemsley, "Polynesian Plants collected by J. J. Lister."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. S. U. Pickering, "Hydrates of Potassium, Sodium, and Lithium Hydroxides." 2. Dr. J. Clark, "Notes on Marsh's and Reinoch's Tests for Arsenic." 3. Dr. A. Richardson, "The Formation of Hydrogen Peroxide in Organic Liquids." 4. Messrs. J. B. Hannay and A. E. Leighton, "The Supposed Saponification of Linseed Oil by White Lead." 5. Mr. L. Reed, "Notes on the Capillary Separation of Substances in Solution."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Atmosphere."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Forrest Lectures.) Dr. William Anderson, "The Inter-dependence of Abstract Science and Engineering."

Friday, May 5...United Service Institute, Whitehall-yard, 3 p.m. Major E. S. May, "Manœuvres of Masses of Artillery."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. Shelford Bidwell, "Fogs, Clouds, and Lightning."

Chemical, Burlington-house, W., 8 p.m. Hofmann Memorial Meeting. Addresses by Lord Playfair, Sir F. A. Abel, and Dr. W. H. Perkin.

Geologist's Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. Annual Meeting.

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Junior Engineering Society, Westminster Palace Hotel, S.W., 8 p.m. Mr. A. H. Bromley, "Gold Mining Machinery."

Saturday, May 6 ... Royal Institution, Albemarle-street, W., 3 p.m. Dr. Henry Craik, "Johnson and Milton."

Journal of the Society of Arts.

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FRIDAY, MAY 5, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CANTOR LECTURES.

On Monday evening, May 1, Mr. Lewis Foreman Day delivered the fourth and last lecture of his course on "Some Masters of Ornament."

On the motion of the Chairman (Mr. Hugh Stannus), a unanimous vote of thanks was passed to the lecturer.

The lectures will be printed in the *Journal* during the summer recess.

FOREIGN & COLONIAL SECTION.

On Tuesday evening, May 2, a paper on "Russian Industrial Art" was read by E. Delmar Morgan. J. Hungerford Pollen presided.

The paper and discussion will appear in the *Journal* of May 19.

COVERS FOR JOURNAL.

For the convenience of members wishing to bind their volumes of the *Journal*, cloth covers will be supplied post free for 1s. 6d., on application to the Secretary.

Chicago Exhibition, 1893.

OFFICIAL CATALOGUE OF THE BRITISH SECTION.

The first edition of the official catalogue of the British Section is now ready. The volume consists of upwards of 600 octavo pages, and includes, in addition to the usual information, short articles prefacing the particulars of each department. The list of contributors is as follows:—Agriculture, Ernest Clarke, Secretary, Royal Agricultural Society; Food and Drinks, R. Bannister; Horticulture, Prof. W. Thiselton Dyer, F.R.S., Director of Kew Gardens; Live Stock, Ernest Clarke; Sea Fishing, Prof. E. Ray Lankester, F.R.S.; Angling, R. B. Marston, Editor *Fishing Gazette;* Mining, C. Le Neve Foster, D.Sc., F.R.S.; Metallurgy, Prof. W. C. Roberts-Austen, C.B., F.R.S.; Machinery, H. Graham Harris, M.Inst.C.E.; Railways, Sir Douglas Galton, K.C.B., F.R.S.; Shipping, Prof. Francis Elgar; Carriages, George Norgate Hooper; Cycles, George Lacy Hillier; Manufactures, R. H. Hooker, Assistant Secretary, Statistical Society; Pottery, Wilton P. Rix; Textiles, Swire Smith; Electricity, Prof. W. E. Ayrton, F.R.S.; Fine Arts, John Evans Hodgson, R.A., Professor of Painting to the Royal Academy of Arts; Education, J. G. Fitch, LL.D., H.M. Chief Inspector of Schools; Scientific Apparatus, Prof. Silvanus P. Thompson, F.R.S.; Photography, Capt. W. de W. Abney, C.B., F.R.S.; Music, J. A. Fuller Maitland; India, S. Digby, Secretary to the Indian Section of the Society of Arts.

Copies of the catalogue can be obtained from the publishers, Messrs. William Clowes and Son, Limited, 13, Charing-cross.

SOCIETY OF ARTS EXCURSION TO CHICAGO.

The Council of the Society of Arts, acting as the Royal Commission for the Chicago Exhibition, have arranged with Messrs. Thos. Cook and Son to organise a special private excursion to the Chicago Exhibition for members of the Society of Arts. The excursion will last from July 22 to August 23, and will cost £65.

Those members who intend to avail themselves of this offer are requested to make early application to the Secretary, as the list will be closed on Saturday, May 13.

PASSENGER RATES TO AMERICA.

The Hamburg-American Packet Company offer to convey members of the Society of Arts to New York at a rate of £14, single fare, first-class, on the understanding that at least fifty members travel by this line during July and August. The company's steamers sail from Southampton every Friday.

Proceedings of the Society.

INDIAN SECTION.

Thursday, April 24, 1893; Sir ALEXANDER WILSON in the chair.

The paper read was—

THE MANUFACTURES OF INDIA: THEIR STATE AND PROSPECTS.

By SIR JULAND DANVERS, K.C.S.I.

One of the most interesting and important problems of the present day in connection with India is how her resources can best be developed. There are some thoughtful persons who view with alarm the rapid increase of her population, and who begin to doubt whether the country will be capable hereafter of sustaining the millions of inhabitants, for whose preservation from disease and death every effort is now being made. I cannot say that I sympathise with these views. I have sufficient belief in the resources of the country to think that the course of events will avert such a catastrophe. To judge of her self-supporting capabilities, we need only look back upon the last quarter of a century to see what has been accomplished in the way of increased external commerce and internal activity. Sir William Hunter has lately graphically described to this Society the progress which has been made since 1858, when India came under the direct government of the Crown; how her security has been effected, and how her material advancement has proceeded, *pari passu*, with her moral and intellectual improvement. And here I would ask permission to say, in passing, that, while I do not suppose that Sir William Hunter, in confining his interesting and instructive remarks to this epoch, intended to cast censure or blame upon the administration of the East India Company, his words have been construed by some to be open to such an implication. I take this opportunity, therefore, of pointing out that it was not through supineness, indifference, or the want of an enlightened spirit that the development of the country was not as rapid during the 30 years preceding the extinction of the Company as it has been since. As pioneers in the field of enterprise and improvement, the old Court of Directors and their distinguished servants were as sagacious as they were energetic. I could recount the efforts made under their directions to introduce into India and to improve agricultural industries, such as cotton, tea, silk, tobacco, and others. I could furnish proof, also, of their anxiety to construct railways and telegraphs, and to extend irrigation works; but this is unnecessary. I will only add that the progress made since 1858 is due, not only to good government, but to the policy which the Company commenced and to the vast changes wrought by steam, electricity, and machinery throughout the world. Capital and science have, indeed, done good work in India, and, accompanied by skill and energy, and a wise administration, they will do still more. The Suez Canal and the improvements in steam navigation have afforded the means of cheap and speedy intercourse with Europe, and the railways within her borders have conveyed to her ports for consignment to distant markets her grain and seeds, cotton and jute, tea and coffee, and many other products, to an extent that no prophet of the last generation would have ventured to predict.

I am glad to be able to quote the opinion of Mr. J. A. Baines, I.C.S., the Census Commissioner of India, on the more cheerful aspect of the question of India's development. In an exhaustive paper on the "Distribution and Movement of the Population o[f] India," read before the Royal Statistica[l] Society in December last, he comes to th[e] conclusion, after mature deliberation and wit[h] a large and recent experience, "that rela[-] tively to its means of subsistence, India is no[t] over-peopled; that, even in the favourabl[e] circumstances of the last ten years, th[e] population has not increased in an undu[e] proportion to those means, whilst the rate[s] of increase, in its process of production an[d] purchase, indicate a general rise in the well[-] being of the community at large."

More land has been brought into cultiva[-] tion, and irrigation has been extended t[o] fertilise the soil. Agriculture has improved[,] and there is room for further expansion; bu[t] it is, by a long way, the preponderating industr[y] of the country, and this it is which furnishe[s] ground, not for melancholy forebodings, bu[t] for serious reflection and vigorous actio[n.] What is wanted is the extension of industri[al] employment. There are, as we shall presentl[y] see, various other occupations, besides agri[-] cultural, scattered over the country, but, com[-] pared with agricultural pursuits, they provid[e] at present an insignificant means of support [to] the people. It is calculated that about 9 p[...]

cent. of the population are employed in factories and handicrafts, while 83 per cent. are engaged in agriculture. The total value of exports from India in 1891-92 was Rx. 103,550,000, of which only Rx. 14,300,000 consisted of manufactured goods. It will readily be admitted that it is not desirable for any country to be dependent on one source of wealth. Agriculture, no doubt, in India will hold its own, and continue to be the main industry; but, if besides exporting her raw material, she could use more of it in supplying her own and foreign markets with the manufactured article, an important step would be taken in promoting the prosperity of the country. There would be no interference or rivalry, as there was in England, between manufactures and agriculture. The resources of India are such, that in many cases one would react beneficially on the other, and both would work together for their mutual advantage.

The object of the present paper is to examine the present position of Indian manufactures, and to consider their future prospects.

The term manufacture may be taken as meaning the transformation of an original substance, by the dexterity of manual labour, into articles for the use of man. The motive-power may be the deft fingers of a Dacca damsel or the steam-engine of a cotton-mill, and the article produced may be a pin or a steam-engine, a sheet of paper, a wine glass, or miles of cloth. In each case, the process of manufacture has to be gone through; but, as Sir George Birdwood has truly observed, "in Europe, the word manufacture has come at last to lose well nigh all trace of its true etymological meaning," and is now generally applied to articles made by machinery. In considering, however, the subject of Indian manufactures, it is impossible to omit a brief examination of the numerous handicrafts and art industries which would not perhaps now come under the ordinary acceptation of the term "manufactures." From time immemorial India has been famous for its productions of this kind. Mechanical labour, aided by a well-trained eye and delicacy of touch—the result, probably, of hereditary instincts—has produced beautiful examples of handicraft. The embroidery and leather work of Kattyawar are spoken of by Marco Polo, in the 15th century, as "marvellously beautiful things." "The inhabitants," he says, "are good people, and live by their trade and manufactures." At a less remote period, but at a time when communication was not only imperfect, but was accompanied by risk and danger, the spirit of enterprise visited India, and opened to the Western world the riches of its art industries. Its metal and ivory-work, its shawls and embroideries, its carpets of cotton-wool and silk, found their way to this country, and "argosies with portly sail" traversed the Western seas. The same patterns and the same designs have existed for years, and in particular localities, and amongst different families and castes, and, whatever their origin may be, they show a genius for composition and arrangement of colour which is the admiration of all lovers of art. "The Indian workman," says Sir George Birdwood, "from the humblest potter to the most cunning embroiderer in blue, and purple, and scarlet, is not the less a true artist, although he seldom rises above the traditions of his art." It is most desirable that these art industries should be preserved and kept pure and uncontaminated. With the best intentions harm has sometimes been done by attempting to graft Western ideas upon Eastern designs, whereby purity and harmony have been converted into crudeness and deformity. I do not mean to say that East and West may not learn something from each other, but great discrimination and pure taste are necessary for success in the technical instruction given in our Indian schools of art, and it would be well to raise and stimulate this class of employment by encouraging those who show a decided aptitude for art—to pursue it in preference to quill-driving and book-keeping. The metal work, the pottery, the inlaid wood-work, the embroidery, exhibit a variation in shape, colour, and pattern, which have been for years identified with different localities and castes. It is not easy to trace how these industries were first established. In some cases it was probably accidental; in others, it was due to the migration of a family of experts from distant parts; and sometimes, perhaps, to an inventive genius springing up, or to suitable material being found in the neighbourhood. Persia was, no doubt, the source from which many of the artistic devices which characterise Indian workmanship came.

In May, 1884, Mr. Baden Powell gave this Society an interesting account of some of the handicrafts and art industries of India, especially those carried on in the Punjab, and described the characteristics of Indian labour in various parts of the country. He showed

that some of the work executed could be traced to a Mohammedan origin, while others contained evidence of Hindu ideas and feelings. He viewed the subject very much from an artistic point of view, and explored a field in which he has personally done much good service. I do not propose to go over the ground which has been so well covered not only by Mr. Baden Powell, but by Sir George Birdwood, and Mr. T. N. Mukharji, and Forbes Watson. Nor will it be possible, within the scope of this paper, to do more than notice briefly the principal industries of the kind referred to.

Allusion has been made to the choice fabrics of cotton, silk, and wool, which, centuries ago, adorned the houses of the rich in India, and found their way to Europe; but, besides this high class of textile products, ordinary articles of clothing were produced from the village spinning wheels and looms. These home industries have continued from very remote periods, but have, during the last fifty years, been greatly interfered with by the cheaper cotton goods imported from England. An additional competition has now sprung up in India itself, and it cannot be doubted that the machine-made textiles will gradually cause the hand-made cloths to diminish. This result is, of course, inevitable in every country where progress is being made. It is said that the fabrics produced by the village looms are of greater strength and better quality than those made by machinery, so that a supply may be continued to those who are ready to pay a higher price for a superior article.

One of the first fabrics weaved from Indian cotton, which will occur to everybody, is muslin. The beauty and lightness of Dacca muslin still holds its pre-eminence, although its sale is now very limited, The fineness of its texture is described by the well-known names of "Evening Dew" and "Woven Air," and is proved by the traditional test of passing twenty yards of it, one yard wide, through a lady's wedding ring. It has been said that the fingers of the women by whom it is spun are losing their cunning; but a very fine fabric is still made, being used only by the rich and noble. The greater the length and number of threads, and the less the weight of the piece the higher is the price. The lower qualities, used for turbans, veils, and clothing, have generally been superseded by the machine-made article from Europe. The antiquity of Indian muslin is traced far back by Sir George Birdwood, who is of opinion that in the time of the Chaldeans it was carried into Babylonia as a regular article of trade, and that cotton also, in the form of the Arabic tunics, became known to the Greeks before the age of Homer. The word cotton does not appear in the Old Testament, but Sir George Birdwood, with his knowledge of Hebrew and Sanscrit, is able to point out the interesting fact that the passage in Esther (chapter i., v. 6) which runs, "Where were white, green, and blue hangings fastened with cords of fine linen?" should be rightly translated, "where were white and blue (striped) cotton hangings?"

Calico, like muslin, was in times past much thought of in England. It is supposed to have been first introduced from Calicut, from which place it derives its name. Its texture and printed patterns were the admiration of our great-great-grandmothers, and it was much worn for dresses in this country, so much so that it alarmed our silk weavers, in whose interests a law was passed in 1721, prohibiting the use of printed calicoes. Fifteen years afterwards this was modified so as to admit of their being worn, "provided the warp thereof was entirely of linen." They had their day, but were ultimately superseded by the machine-made stuffs of England; and these have, in a great measure, also displaced the hand-loom fabric in India itself. A common kind is still made there, and the day may again come when the wheel of fortune will enable it to take a larger place in the Indian market.

Silk has, for a long period, been made and largely used in India, and, in former times, silk fabrics were exported to Europe. There has, however, always been difficulty in cultivating the domesticated mulberry-feeding silkworm. More than a century ago, the East India Company made efforts to introduce the Italian system; but, while improvements were made in the filature, the experiments ultimately failed, apparently from the climatic effects upon the mulberry tree, and the silk industry became dependent for its native supply on the wild insect. The fabric thus produced is known as the Tasar silk. The trade in Indian silk is now small. In his last report Mr. J. E. O'Conor speaks in a desponding tone as to its decadence:—"It is clear," he says, "that Indian silk is not able to hold the market: our exports to foreign countries amounted to little more than half the imports." Most of the manufactured article is made from the raw material imported into

Bombay and Burma from China and Europe. I would venture to express the hope that the present condition of this industry should not produce despondency, and that it will still be thought worth while to apply skill and science in overcoming the physical difficulties of cultivation.

To pass from silk to embroidery is a short step, silk brocades forming the foundation for some of the most beautiful specimens. Few articles of Indian ware excited more admiration at the various international exhibitions that have taken place than the *kinchâbs*, the horse-trappings, the *kârehobs*, and *jémdanis*. It is truly an art industry, brought to perfection by the richness of the material used, as well as by the beauty of the patterns and the harmony of colours. It is surprising that, with our growing love of decorative art and our improving tastes, more of this kind of ornamentation is not seen in our halls and reception rooms.

Carpets, on the other hand, have found their way into English homes and are very generally used. In former times a specimen here and there, more often in the shape of rugs than full-sized carpets, might have been seen in houses connected by association with the East, but after the Exhibitions of 1851 and 1862, a considerable trade was started and has continued. They are made of cotton-wool, silk, goat's hair, and these materials mixed; and are hand-woven, seamless, and of various sizes. They, of course, vary in quality and price, but, as in most things, the best are the cheapest in the end, from their durability, elasticity and softness. Carpet-making is a large jail industry, but there are private manufactories in various parts of the country. Competition, and the demand for a cheap article, have not been without ill-effects. Attempts are sometimes made to graft European ideas upon Eastern patterns, and the result is always disastrous. The use of inferior dyes has also become too common. The manufacturer and the customer should be strenuously warned against these injurious processes, and be persuaded that, if the industry is to flourish, its character for pure design and good workmanship must be maintained.

Woollen fabrics are numerous, and vary much in kind and degree. The principal animals which supply wool and hair for the purpose are sheep and goats of various breeds, and the camel. The finest wool is produced in the districts and hills to the north-west of India, and the manufacture of shawls in Cashmere and the Punjab became a flourishing industry. The beauty of their texture and patterns has been for ages so well known that it is unnecessary to dwell upon it. They remain unrivalled, although efforts have been made to imitate them. The finest and softest are said to be made from down, called *pusham*, being the under fleece, between the skin and hair of the animal. The industry has not escaped the vicious practice of adulteration, and a mixture of an inferior wool with that of the highest quality has sometimes been attempted. The discovery of the imposture naturally gave rise to suspicion and distrust, and led to a falling off in the demand from Europe. The Maharaja of Cashmere, alarmed at this result, some time ago issued stringent regulations with the view of securing a pure article from all manufacturers in his territory. The Rampur chudder, now so familiar to English ladies, is made from the wool of sheep in Ladak and the Punjab, and derives its title from the name of a place on the Sutlej. All these shawls are hand-made. The greatest care is taken in cleaning and preparing the wool and in spinning the yarn before the elaborate process of drying and working up the material for the loom is commenced. The system pursued is too long to describe in this paper. Full and interesting accounts are given in Dr. Forbes Watson's work on the "Textile Manufactures and Costumes of the People of India." The cloth produced from camel's hair is made into chogas and thick coarse fabrics. A finer description is also used for dressing-gowns and other garments. A considerable demand for these articles comes from Russia. Blankets, bedding, mats, and rugs are also made of sheep's wool, with goat's and camel hair mixed. The export of woollen manufactures is at present on the decline.

Hides and skins are exported to the value of from twenty to twenty-eight lakhs per annum, and a large proportion of this is tanned in the country. There are now about forty-five tanning and leather factories. One of the results of a famine is that the supply of skins is increased in the districts where scarcity occurs. For export purposes the skins are not carefully enough prepared. The curing might be improved with better methods. The leather now made is principally for home consumption, and is made into saddlery, bottles, sandals, shields, shoes, and slippers. Much ornamental and embroidered work of a highly artistic character is produced. Specimens may have

been seen in the various international exhibitions. Boots and shoes are now the most flourishing branch of the leather trade. Within the last few years, they have been supplied to our troops in India from the Indian factories.

I turn now for a brief space to the metal-work. A very interesting exhibition, which is probably in the minds of many present, took place only a short time ago at the Imperial Institute. Beautiful specimens of this particular branch of art industry might have been seen there. In many places, gold and silver are turned into ornaments and into articles of use for the table. While some are beautifully chaste, others are only rudely finished, and are more curious than pretty. In addition to trays, goblets, plates, and bowls, the articles peculiar to India are the rose-water sprinklers, hukkas, betel boxes, water vessels, &c. The places most famous for gold and silver work are Cashmere, Lucknow, Cuttack, Rajputana, in Northern India; Ahmedabad and Cutch in the Bombay Presidency; and Dindigal, Madura, Arcot, and Cochin in Madras. Burma also has not neglected the art. The work is as various as the places, each having its distinguishing feature. Speaking generally, and, comparing Indian with English plate, while recognising the beauty of its form and pattern, there would appear to be a want of finish, and, as we know from the sad demolition which often took place when brought into this country, too large an ingredient of alloy. The removal of the import duty, and the regulations with regard to hall-marking, will, it may be hoped, not only have the effect of improving its quality, but of increasing the desire to make it as perfect as possible.

Gold and silver ornaments, jewellery, and trinkets of all kinds, filigree work, and wire-drawing decorations, are made in most towns of India. The love of the native for personal adornment, and the means of hoarding provided by the conversion of the precious metals into ornaments for various parts of the body (the head, nose, ears, and ankles), create a local demand, which employs a large number of people. Jewellery, like plate, generally needs the finishing touch to bri it up to the European standard, and precious stones are thought more of for their weight than brilliancy. The cutting of gems is thus sparingly exercised, and a polish is considered sufficient. It will be recollected that the Koh-i-noor was, after its arrival in this country, on the advice of competent judges, ordered by the Queen to be recut, and that, although reduced in weight from 180 to 102¼ carats by the operation, its brilliancy was greatly intensified; and that, in the words of Mr. William Pole, it became, "what it never was before, a most splendid jewel, worthy of its royal mistress, whose unsullied diadem may it long adorn."

Brass and copper are largely used for vessels of domestic use, as well as for ornaments and personal decoration. The industry is an important one, and much skill and ingenuity are applied to the work. The Hindus are said to prefer brass, and the Mohammedans tinned copper for their cooking utensils. The Benares brass ware, with its bright shimmering surface, is now well-known in this country. It is said to have been imitated at Birmingham, and that the ignorant and unwary have been caught by it. The Indian ware is worked out by the skilled artificer, who, with a simple hammer in one hand, and a pointed instrument in the other, engraves, without any pattern or tracing before him, the design which is in his head. In Lucknow, Delhi, Moradabad, Amritsir, and other towns in the North-West Provinces and the Punjab, as well as places in the Central Provinces, Rajputana, Madras, and Bombay, the metal industry is carried on. In fact, all over India the aptitude of the native in this department of industry is exemplified.

There are other crafts, some almost unique in their character, such as enamelling, lacquer-work, inlaid-work, stone and wood-carving, ivory-carving, which it is impossible to do justice to in the limited space of this paper. The same may be said of pottery and glass, which have existed from very early times, and are still pursued. I must refer my hearers to the excellent work of Sir George Birdwood on "The Industrial Arts of India," as well as to Dr. Watt's valuable "Dictionary of Indian Products," and the interesting accounts by Mr. Baden Powell, Mr. J. L. Kipling, Sir Edward Buck, Mr. Purdon Clarke, and others of the industries of various districts. To the labours of these gentlemen in the country itself, and to their instructive reports, we owe the knowledge we now possess on the subject, and to the same cause is due the preservation of what is good, and the introduction of improvements in the arts themselves. I would also recommend a visit to the well-arranged collection of specimens of work in the Indian Museum at South Kensington.

It will be seen that the handicrafts above

mentioned constitute an important part of the large earning industries of the country. They are important as well for the higher occupation they provide as for the artistic character of the work performed. It is true that imitation more than originality and individuality is brought out, but there is an undeniable charm in the general results produced. What is meritorious should be preserved and made the foundation upon which improved appliances and an instructed intelligence may build a useful and profitable superstructure. Besides these industries, others may be mentioned which neither come under the category of manufactures, according to the usual acceptation of the term, nor of crafts and arts, and yet might be made the means of further profitable employment and lucrative trade.

Tobacco, for instance, is one which it would appear might become a greater source of profit if more attention were bestowed upon it. The climate and soil of Southern India and Burma are favourable to its cultivation, and with the careful choice of the seed, a better treatment of the plant, and a more skilled preparation of the leaf, greater demand than now exists in this country for both tobacco and cigars would probably ensue. In the time of the East India Company, as well as since, attempts have been made through Government agency to obtain the most suitable plants and to apply the best means of cultivation and manufacture. While improvement has taken place, there is room for more. According to the last official statistical tables there are 31 farms and factories established in India, 29 of which are in the Madras Presidency. Exports are small, and show little increase. In 1881-82, the value was Rx. 1,15,000, and ten years after, in 1891-92, Rx. 1,41,000.

In fibres, again, there would appear to be an opening for more commercial activity. The country provides a great variety. The rhea plant, aloes, grasses of different kinds, mallows, the barks of trees, jute, all grow luxuriantly, and are worked up into materials for domestic use, such as ropes, bags, clothing, paper, canvas. A proper selection and preparation of the plant, and a suitable machine for cleaning the fibre, are needed to obtain the desired results.

The bamboo is also a plant which is most serviceable in a variety of ways, and might be applied to many uses in this country. The canes vary in size from that of a walking stick to a thick pole. In India they form the framework to dwellings, and bridges of a light description, and they are employed in the construction of light but strong furniture, as well as for musical instruments. A fibre is also obtained from them, which is converted into mats, ropes, and paper. The palm, likewise, furnishes material for many useful domestic purposes, and might be profitably applied to similar objects in this country.

Teak has already found its way, in not inconsiderable quantities, to this country, and is used in the construction of dwellings, in shipbuilding, for carriages, and furniture. The cheap labour of India suggests that, besides exporting it in the shape of logs or hewn timber, it might be formed into made-up material, as in Norway and Sweden, for ready application to sheds, houses, &c.

The cultivation and manufacture of tea, which is now general on the slopes of the Himalaya, and on the higher grounds in Southern India, I will only allude to as a proof of what may be done by perseverance and care. I can remember the time when Indian tea was distributed in this country as a curiosity. It was the product of the experimental gardens, instituted by the East India Company, for the purpose of showing that the plant would thrive, and that the leaf could be prepared for the English breakfast-table. The industry was first started in Assam. It proceeded slowly at first, but it afterwards grew rapidly, and extended to other parts of India. In 1890 its cultivation covered an area of about 1,000,000 acres. In 1871 the quantity exported was 17,187,328 lbs.; in 1891 it had reached 120,149,407 lbs., of which 111,169,000 was sent to Great Britain. While China, in 1871, exported 146,687,870 lbs. to Great Britain, and, in 1891, only 67,256,263, India in the latter year sent 109,638,000 lbs., besides considerable consignments to Persia and Australia.

Opium and indigo are very important industries, and a large number of persons are employed in the preparation of these commodities for foreign markets. The climate and soil are very favourable to their growth. The exports of opium have varied during the last ten years between 85,166 chests, at a value of Rx. 10,115,936, and 95,839 chests, at a value of Rx. 11,077,669. As is well-known, opium becomes an important source of revenue, which is paid by a willing customer in China, and thus saves the pockets of the Indian taxpayer. The exports of indigo ranged between 118,426 cwt. and 168,590 cwt. during the ten years ending with 1891-92

the value being Rx.3,073,125 and Rx.4,640,990 respectively. Indigo is indigenous to India, and is referred to by Marco Polo so long ago as the 13th century as an article of trade.

Quinine is another product which has been successfully introduced and established in India through the exertions of the Government. In 1858 Mr. C. R. Markham, C.B., was deputed to South America for the purpose of collecting cinchona seeds and plants from the forests of the Andes. The attempts were at first unsuccessful: the plants were injured by travel, and arrived in a dying state; but the enterprise was persevered with, and, other plants having been obtained, experiments were made on the Neilgherry Hills. The cinchona is now flourishing at Ootacamund, where a forest of 2,000,000 of trees may be seen. The bark was at first sent to England, and the drug made from it sent to India; but lately India makes her own quinine.

Breweries are a modern industry, but like others have, with care and attention, become firmly established, and supply a suitable beverage for the country. There are now twenty-two breweries in operation, distributed over the whole of India, and always occupying high ground, such as Darjeeling, in Bengal; Ootacamund, in Madras; Missouree, in the North-West Provinces; and Simla, in the Punjab. The quantity produced in 1881, when there were nineteen breweries, was 2,448,711 gallons. In 1890 it had increased to 5,192,572 gallons and of this 3,093,021 were purchased by the Commissariat Department.

We have, so far, been considering those industrial pursuits, many of which have existed for a long series of years, and which are dependent on manual skill, without the aid of machinery. We now come to those which have been introduced within recent times, and are on a scale requiring an organised system of labour, powerful machinery, and steam or water-power. As I have already said, it is a natural development of the resources of a country to increase the value and variety of its products by converting the raw material into substances for the use of its inhabitants, and for exportation to foreign countries. No better example of the effects of this process could be furnished than by the coal and iron industries of Great Britain, which were the foundation of our manufacturing prosperity. The conditions of India may be regarded as favourable to progress in this direction. She has the raw material at hand; she has cheap labour; she commands a fine commercial position, especially since the Suez Canal was opened; she has good ports, and a system of internal communication which conveys her produce safely and cheaply to the centres of trade and industry. Water-power is, in many places, available, and the prospect of producing steam-power by means of her own coal is yearly improving. Lastly, she has the benefits of a firm and parental Government, backed by an Imperial power, which secures peace and internal safety, as well as protection against external attack; and she lives under sound fiscal laws. It is not surprising that, with all these advantages, manufacturing industries, with all the new modern appliances, should have been started, and should have made some progress.

The most important manufacturing industry is that of cotton, which is naturally connected with Bombay, where the raw material is close at hand, and where enterprise is keen. The start was made in 1851, and in 1857 we find two mills established there, and worked by a joint-stock company, with a capital of $35\frac{3}{4}$ lakhs. They contained 1,267 looms and 67,300 spindles, employing 1,933 men, 466 women, and 352 young persons. The object was to supply the Indian market. The import duty of $3\frac{1}{2}$ per cent. on Lancashire yarns existed, and the cost of transport from England was much greater than now. Altered circumstances, and the establishment of railways in the interior, gave an impulse to the industry, and new mills were added. The movement was overdone, and a reaction took place; but subsequently activity was resumed. Freights being favourable, and the rate of exchange lower, the commencement of an export trade to China and Japan was the result. During the ten years that followed 1857, only five mills were added. In 1878 there were 28 mills in operation, and in 1888, including Surat, Ahmedabad, Broach, Baroda, and Belgaum, there were 81. In 1890, the number had increased to 89, with 18,192 looms and 2,330,468 spindles, the men employed being 45,448, the women 17,734, and the young persons and children, 15,217, making 78,399 in all. The capital represented was estimated at 7 crores 87 lakhs. In Bengal, principally at Calcutta, there are eight mills, having 297,448 spindles, and employing 8,790 persons. In the Madras Presidency there is the same number, with 173,152 spindles, and employing 5,942 persons. The North-West Provinces have five mills—four at Cawnpore and one at Agra—the Punjab two, and Central

India six. The whole of India gives, in 1891-92, a total number of 126 mills, representing a capital of nearly 11 crores, having 24,670 looms, 3,272,988 spindles, and employing about 112,000 persons. It is estimated by Dr. Watt that these mills consumed about 36 per cent. of the raw cotton supplied. It will thus be seen that the progress has been very gradual, but, at the same time, significant. There have been periods of depression and instances of suspension, but, on the whole, a decided development is going on. While the Indian-made yarns have increased in quantity, the imports of English manufactured cloths have also increased. In 1881-82 they amounted to Rx. 21,230,000; in 1891-92 to Rx. 28,689,471.

The value of the exports of cotton manufactures from India have, within the same period, increased from Rx. 2,010,516 in 1881-82, to Rx. 7,035,036 in 1891-92. The chief markets for these goods are China, Japan, and Africa. "Of the yarn trade," says Mr. O'Conor, "about 94 per cent. is carried on with China and Japan. Piece-goods are taken to an extent of about 70 per cent. to the Asiatic and African littoral west of Bombay, and most of the remainder finds its markets in Ceylon and the Straits." For piece-goods, it would appear that Japan is herself setting up mills to meet the wants of her own population. The demand for cotton goods in the districts of the Red Sea, held by Italians and English, is now constant; and we have the testimony of Signor Giuliano that "the Indian industry has known better than the Italian how to adapt itself to the taste of the African consumers."

As is well-known, the import duties on the coarser kinds of cotton twist and goods were abolished in 1878-9, and on all descriptions in 1881-82; also that the Factory Act of 1892 imposes limitations on the use of labour, and prescribes the conditions, as in this country, on which women and children may be employed. The age of a child must not be below 9, and the maximum time of their employment 7 hours per day; that for women, 11 hours. Both these measures were right and proper, and desirable in the interests of India and of this country. When the import duties were removed, the Indian manufacturer did not allow himself to be depressed or discouraged. On the contrary, he acted as all men of spirit and energy do under similar circumstances, and met the altered conditions of his business by fresh exertions, and by making the most of natural resources. By means of improved machinery, better methods and greater economy in their operations, and assisted by favourable freights and the low exchange, the Bombay manufacturers have maintained their position, consoling themselves with the reflection that their gigantic rivals at Manchester do not altogether command the market. It was thought by many at the time that India was hardly used, but the result has shown that the stimulus of competition will bring forth exertions and skill more than sufficient to counterbalance artificial supports. In the four years from 1874-5 to 1877-8, during which the duties on the lower description of British manufactured goods existed, the average annual value of goods exported from India was Rx. 782,728. In the next four years to 1887-2, when all duties were removed, the average annual exports were Rx. 1,734,844, and in the four years, between 1881-2 and 1885-6, they amounted to Rx. 3,101,273. In the year 1890-91, the value was Rx. 6,543,364. The fall in exchange and low freights have no doubt had something to do with this result. The state of things aroused in England two great motives of human action, self-interest and philanthropy. At Manchester the cost of production in each country was most carefully scrutinised, the rate of exchange and the cost of labour being taken as factors. Why, it was asked, should Lancashire be subject to legislative restrictions as to labour, and India be allowed the freedom of making its own arrangements, and why should not the women and children of India be protected from too severe a strain upon their powers? The result was the Factory Act, before referred to, which, so far as I can learn, has worked beneficially for all interests concerned. Suspicions were no doubt entertained by some in India that the real object of those who, in England, promoted this movement, as well as the policy of removing the import duties, was to favour English manufactures. They perhaps thought of the time when the policy of this country as regards the trade and manufacturing industries of India was not a generous one, when differential duties on her produce were imposed to protect colonial interests, and when the use of her calicoes was actually prohibited, to prevent interference with a home industry. But times are altered, and whatever particular sections of the community may think, no Government would, I believe, entertain the idea of pursuing a policy which they did not consider conducive to the real interests of the country.

The Marquis of Lansdowne, on the passing of the Act of 1891, said "Our proposals have been framed with an earnest desire to hold the balance fairly between the interest of Indian industry and the demands which have been made for even more strict regulation of the conditions of factory labour." We shall all recognise the duty of the paramount power to treat India as an integral part of the great Empire under the benign sovereignty of the Queen of England and Empress of India. Nobody will deny that the progress of material prosperity should be accompanied by philanthropic efforts to secure social improvement. Regulations, therefore, such as are made under the Indian Factory Act and the Steam Boiler Act for the prevention of abuses, and for the protection of the weak and helpless, were not only legitimate but desirable. That some effect upon the manufactures of this country will be produced by the expansion of similar industries in India cannot be disputed. Whatever goods are made at a cheaper rate to meet the wants of the Indian people, or to be consigned to foreign countries, will take the place of English manufactures, just as British goods have been for a long time supplanting Indian-spun fabrics. But at present this effect is inconsiderable, and Lancashire, instead of frowning at Bombay, can afford to smile at her progressive attitude. The amount of cotton twist and yarn which India receives annually from the United Kingdom may be taken at from 50,000,000 lbs. to 52,000,000 lbs., and of piece-goods from 1,800,000,000 to 2,000,000,000 of yards, while the whole output from the Indian mills for home consumption and exportation may be taken at about 400,000,000 lbs. It is said that during the recent strikes in Lancashire 15,000,000 spindles have been idle. The whole number of spindles at work in India is about 3,200,000. England has more to fear from these strikes, labour disputes, and the action of ill-advised trade unions, than Indian competition. When these occur, England's perplexity is India's opportunity, and the opportunity also of European countries which are keener competitors than India.

India seeks for no favour; but let her put forth what strength she has and make the most of her opportunities. If she does this, we are, in the words of the present Viceroy, "justified in looking forward with the most sanguine anticipations to the future of this great industry." In connection with it, there are other mills for ginning, cleaning, and pressing cotton, amounting in all to 350, of which 175 are in Bombay, 25 in Sind, 18 in the Punjab, 16 in the North-West Provinces, 34 in Madras, 24 in Central Provinces and Rajputana, and 95 in the Hyderabad Assigned Districts.

But I have dwelt long enough upon cotton, and must proceed to consider other manufactures which have sprung up during the last few years, and are capable of expansion. The first of these is jute. I believe I am right in saying that the Crimean War, when Russian hemp was excluded from the British market, was the means of bringing Indian jute into prominent notice. The exigencies of the Scotch and Irish manufacturers was India's opportunity, and quantities of the raw material were exported to Great Britain from Bengal. It had found its way by driblets before that period, but in 1855-56 the value exported amounted to Rx. 32,90,760. In 1874 it had reached Rx. 3,24,68,800; in 1882-3, Rx. 5,84,69,000; and in 1889-90, Rx. 8,639,861. It fell off in the two following years, and in 1891-92 was reduced to Rx. 6,848,493. For local purposes it has for some years been made into gunny cloth by hand-looms; but in 1857 a company was formed, with a capital of 40 lakhs, to put up a couple of mills at Barnagore. The number of looms was 769, and of spindles 11,154. Ten years afterwards there were seven factories. In 1878 they amounted to 17, and in 1888 to 24. The industry is principally carried on in Bengal, where the plant is largely cultivated; but Vizagapatam, in Madras, and Cawnpore, can also boast of a mill each, making 26 for the whole of India. In 1890, according to Mr. O'Conor's statistical tables, these mills represented a capital of three crores, contained 8,100 looms, 161,845 spindles, and employed 61,915 persons, of whom 12,472 were women and 10,432 were juveniles. The industry has thus become an important one, and, at certain seasons, there is a large traffic on the river and on the Eastern Bengal railways to Calcutta. In 1882-83, the gunny bags and cloths exported was Rx. 1,487,831. In 1891-92 it was Rx. 2,513,100.

I have already alluded to the hand-loom woollen industries. Besides these, there are five factories in the country worked by steam-power—two at Bombay, one at Cawnpore, another in the Punjab, and the fifth in Mysore. These mills employ 2,582 persons, and work 532 looms and 17,210 spindles. The industry can only be said to have made a start. In Mr. O'Conor's opinion, it is "as yet quite unimportant." He also describes the wool

of such low quality, that it is used only for the manufacture of the most inferior classes of goods." A radical modification of the conditions is, therefore, necessary before an expansion of the industry can be expected. The finer kinds of fabric are made from wool exported from Australia. That the trade is languishing for want of care and energy may be seen by the value of exports, which, in 1881-2, amounted to Rx. 196,683. During the last year mentioned the value of woollen goods imported was Rx. 1,762,000.

Paper-making has long been practised in India, but until recently to a very limited extent. That generally used comes from Europe, the value varying from Rx. 410,000 to Rx. 470,000 per annum. There are, however, abundant materials in the country from which good paper can be made. Seven mills exist in Bengal, Bombay, the North-West Provinces, and Central India. In 1890, 20,500,000 lbs. were manufactured and used for home consumption.

One of the most important manufactures from which great future benefit to the country may be expected is iron. That the ore exists in many parts of India has been abundantly proved, and evidence exists that for ages past iron has been made, by means of small charcoal furnaces, and worked up in various metal industries. The pillar at the Kootub, near Delhi, is an example of an iron structure erected ten or twelve hundred years ago. Attempts have, from time to time, been made by enterprising Englishmen to start ironworks. Some years ago, Beypore, in the Malabar district of Madras, was the scene of one of these endeavours. In the Nerbudda Valley and at Chanda efforts were also made; and in Kumaon furnaces were erected for the purpose of smelting iron ore. But in all these cases, the works, after considerable expenditure, ended in financial failure, and were abandoned. The cost of production was too great, and the high charge for conveyance by imperfect communications made it impossible to supply the material at such prices as would satisfy the market. Railways are now, however, opening up the mineral resources of the country, and the prospect of coal, as well as iron, becoming large industries, is yearly improving. The supply of coal is rapidly increasing. In 1881 there were 47 collieries open; in 1890 the number had increased to 82, and the quantity produced rose from 997,730 to 2,168,520 tons. To ensure the successful establishment of iron works, the ore must not be far removed from coal-fields, or from lime; and the means of transporting the iron to a near market must be at hand. This is the case in various districts of Bengal, and, in one particular instance, where railway communication exists, a decidedly successful effort has been made. At Barrakur, on the East Indian Railway, blast furnaces have been erected, and a considerable quantity of pig-iron has been produced. Here, however, the first attempts were financially unfavourable, and the promoters found themselves unable to continue their operations. The works were then taken over by the Government, who, after keeping them up for a time, and turning out 8,000 tons of pig-iron per annum, re-transferred them to private agency. A company was formed in 1889, under the name of the Bengal Iron and Steel Company, with a capital of £150,000, and borrowing powers. One condition of the lease was that the plant should be so improved and extended as to ensure an output of at least 15,000 tons of pig-iron per annum. Since the works have been taken over, the two blast furnaces have been reconstructed on improved principles, and a new one, 60 feet in height, has been built. This furnace is, I am informed, producing close upon 2,000 tons per month. When the three furnaces are at work, they will be able to produce from 45,000 to 50,000 tons per annum. The fuel used is coke and anthracite coal, in about equal proportions, and both are available in abundance. The flux is not so easily obtainable, the quality of the limestone in the immediate neighbourhood of the works being inferior, and that used has to be brought a long distance, at considerable expense; but hopes are entertained that, by further explorations, this difficulty will be overcome. Foundries for the casting of pipes and sleepers have been constructed, with all the new appliances adopted in similar works in England. During the three years ended 1st October last, since the company commenced operations, the works have yielded 8,433, 8,420, and 10,046 tons per annum respectively. In the present year, it is expected that 25,000 tons will be produced. The quality of the iron is reported to be good, and the "Bengal pig" has become popular. The East Indian Railway Company have been using 800 tons per month in the manufacture of cast-iron sleepers, and other railways have taken 500 tons per month. There has also been a demand for pipes, of which 4,000 tons were cast last year; and the satisfaction of the Chief Commissioner

of the Central Provinces, Sir A. P. MacDonnell, was expressed at the satisfactory manner in which the company had executed a contract for the Raipur Water Works. It is encouraging, after the struggles which this industry has gone through, to find this enterprise in so satisfactory a position. There appears to be no reason why similar works should not spring up in other parts of the country, where railways will, in time, open up coal and iron-fields, and create local demands. It is not likely, however, that any supply will, for a very long period, appreciably diminish the demand for English-made iron.

In addition to the factories already mentioned, there are a number of others connected with miscellaneous industries. There are 38 flour mills, 33 oil mills, 68 indigo factories, 26 ice factories. There are 27 establishments where ærated waters are made, 48 iron and brass foundries, 19 jute presses; also rope works, sawing-mills, potteries, and soap manufactories.

Having thus attempted to describe the present condition of manufacturing industries in India, it only remains to consider what are their prospects. The general condition of the country shows, I think, that, however tenacious of its castes and customs, its crafts and family occupations, it has, under the irresistible force of modern thought and example, and under a system of Government adapted to its peculiar position, come out and eagerly made use of the means afforded it of extending its commerce and developing its internal resources. Manufactories have followed in the train of progress, and the question is, what further means can be used to strengthen this infant industry and to give it a healthy growth. Much depends, in the first place, upon its own inherent power; and, as I have said, that power is not wanting. When what was thought to be a support was withdrawn its vitality appeared. The removal of the import duty was followed by more activity. No favour is needed, and a fair field is all that is desired; but to bring out and more fully develop the resources available, capital is, of course, necessary. I have already indicated certain industries, such as wool, silk, tobacco, and wood, which, I thought with a little more expenditure of money, and more attention to details, might be improved and expanded. So it is with cotton factories and jute mills, and it would be an encouraging sign of enterprise and confidence if capital for the purpose were supplied from the stores of precious metals which are now lying idle in various parts of the country. It may be seen from the official returns that year after year the net imports of gold and silver amount to more than Rx. 10,000,000. Some, no doubt, is converted into personal ornaments, and used for plate and in various metallic works, but the greater part is hidden from view. This is an ancient custom created and fostered probably by a feeling of insecurity and distrust, and was recognised as a duty. Marco Polo noticed that "when the king dies none of his children dares to touch his treasure. 'For,' say they, 'as our father did gather together all this treasure, so we ought to accumulate as much in our time.'" But, however commendable the act of saving may be, a different process might in these days be adopted, and a portion at least of these accumulations might be invested in a way that would give the capitalist interest on his money, and spread benefits over the country. Many native chiefs have shown that they have risen above the old-fashioned idea of duty just mentioned, and have been constructing railways and other works of improvement, which have enriched their territories and made their people happier and better off. Let this example be followed and applied to the industries of the country. At present British capital has been chiefly employed in making the railways which cover the country, and in providing the ships which come to her ports. The cotton factories, the indigo works, the tea plantations, the iron works, have also principally been started and sustained with capital from England. We may hope that the time is coming when the spirit of enterprise and the keen intelligence of the native capitalist will be directed more earnestly and profitably in the same direction.

The Chambers of Commerce and various trade associations have done and may still do good service in watching the commercial interests of the country, and in bringing to notice proposals and measures calculated to promote their advancement. Their influence is valuable in the matter which we are considering, and although, as representing a particular interest, their views may not at times accord with those entertained in other quarters, their object is to promote material prosperity, and their independent position enables them to express plain practical opinions, which are useful alike to the Government and the community.

One point I should like to touch upon in connection with the conduct of the manufacturing

trade generally, and that is the importance of maintaining a high moral tone and of preserving a good name for honest work. Competition is good, but keen competition is sometimes a temptation to sacrifice quality to cheapness, and by adulteration and commixtion to foist upon the customer materials which are not what they appear or are described to be. Such a practice will not answer in the long run.

Other ways of promoting the expansion of manufactures would be by still further extending railway communication, by developing the mineral resources of the country, especially coal and iron, taking care that royalties are moderate and reasonable, and by the removal of obstacles which now impede commerce, and shut out markets where both England and India should find a profitable trade. The increase of trade with European countries which followed the opening of the Suez Canal shows the effect of additional facilities. "In 1890-91," Mr. O'Conor tells us, "our trade with England represented just 50 per cent. of our whole trade; last year it represented 47·4 per cent. In 1881-82 it was as much as 57 per cent. This does not mean that our trade with England has declined. It has increased, but much more slowly than our trade with many of the other countries with which we trade." In former days the trade between India and European countries passed through England. Now it is carried on direct with Austria, Belgium, France, Germany, Holland, and Italy. But other countries should be accessible to India. Whether we look to the right or to the left, we find fields for British enterprise and energy. Africa should engage special attention; so also should Afghanistan, Persia, and the countries beyond, where we allow ourselves to be foiled by a formidable rival, who does not scruple to strain every effort to monopolise trade, and to turn it in the direction of the Caspian and Moscow. In Burma we are close to Siam and China, and while we have been gradually providing railways for the internal requirements of our newly-acquired province, we look shy upon any proposal for connecting them with our neighbours, with whom friendly commercial relations are most desirable and important.

As regards Central Asia, the Hon. George N. Curzon has, in his interesting and exhaustive work on Persia, forcibly described the state of the case, and shows that Russia is systematically making these regions a close preserve for her trade. In 1880 he found in Bokhara that British goods were fast disappearing from the bazaar; and the Russian Finance Minister himself, describing the effect of the Transcaspian Railway, states that "Northern Afghanistan presents a market in which Russian goods find a ready sale, and compete successfully with Anglo-Indian and and other European merchandise." Is the British and Indian merchant and manufacturer content to fold his arms and make no effort to counteract this antagonistic influence? And can no attempt be made to obtain for them the same treatment as Russian traders receive in their dealings with India? We do not wish to employ the weapons that Russia uses. Prohibitory duties on Russian goods are not desired, but only fair and reasonable facilities. So long as railway communication between the Indian frontier and Kandahar is wanting, and onerous transit duties are levied on British goods entering Afghan and Russian territory, the competition is not conducted on equal terms. I trust that Mr. Curzon will continue to urge upon the consideration of the public the points he has so manfully taken up, and that he will be supported by those in authority.

If all legitimate means are taken for opening the markets of the world to Indian commerce, and for stimulating enterprise and energy by developing the country itself, I cannot but think that the prospects of Indian manufactures are good, and that in the whirligig of time she may become a large manufacturing as well as an agricultural country, thus increasing her wealth, and enabling her not only to support, but to improve the condition of her vast population.

DISCUSSION.

The CHAIRMAN, in inviting discussion, said that he had some knowledge of Indian manufactures, having been engaged in them over a quarter of a century, and there were very few points on which he could differ from Sir Juland Danvers. Of the manufactures described, he had personal experience of at least six, and, therefore, he could endorse what had been stated in the paper with regard to those and some others with which he had a less intimate, but still pretty wide acquaintance.

Dr. GEORGE WATT, C.I.E., said that he had listened to the paper with very great interest, and that there were really very few comments that could be made on it; one could but elaborate a point here and there. The great factor in India was its own intrinsic value, its immense capabilities. When the cotton famine took place in Europe, the exports of

that staple from India were about £5,000,000 sterling, but, within 24 months, they expanded to £37,000,000, showing the immense resources of the country. When a specific demand came, the people turned at once in the direction required, and produced the article; and when the cotton famine ceased the exports shrank, but India retained permanently a larger hold on the cotton market than it had ever done before. The greatest errors committed in India hitherto, in connection with agricultural and commercial reforms, had arisen very largely from the mistaken notion that the right way was to import foreign materials, products, and machinery. This has occurred in several important instances with almost disastrous results. Thus, for example, with regard to cotton, the American plant was introduced, and for years Indian reformers struggled hard to cultivate it, but it was found, as might have been foreseen, that the climate and soil were not suited to that particular form of cotton. The only result was that, although some scientists had said it was impossible to hybridise the indigenous cotton, this was what had very largely occurred, and the cotton at the present day was far inferior to what it was before. The proper method was to depend upon the natural selection and development of the native plant. The same mistake was made with regard to sugar. When interest was first awakened in that industry, everyone said they must import the West Indian planter, and make him bring his superior qualities of cane. It would not be far from the truth to say that, in consequence, hundreds of planters were ruined, half a century wasted, and the country covered with ruined factories. The European industry of sugar planting then died out. The imported crop got infected with disease, which spread rapidly, until the natives turned with disgust from it, and went back to their own original cane, which was, in fact, that which had been taken to the West Indies and there judiciously developed. If the same course had been followed in India we might by now have had a strong hold on the sugar market. The same mistaken policy was pursued in respect to tea. When Lord Bentinck was sent out by the East India Company to try, amongst other things, to introduce the cultivation of tea, he went into the subject with enthusiasm. A committee was appointed and an expedition despatched to China to get the Chinese plant, cultivators, and manufacturers. While it was on its way to China, the indigenous Assam tea was re-discovered; it had been discovered ten years before, but no one paid any attention to it. Unfortunately, the China plant was introduced into Assam. The tea industry suffered thereby for an immense number of years; indeed, the planters of many parts of India said their greatest difficulty was the existence of the bushes which had been hybridised. The same mistake was made with regard to rice. India gave America rice; it was there cultivated and improved on national principles until the whole world became immensely interested in the subject of Carolina paddy. Thousands of rupees were spent in India on the vain effort to introduce the Carolina plant. It grew for a few years, but then degenerated to a worse stock than the original Indian rice. The same may be said with regard to rhea. The temperate plant from China was introduced on the tropical plains of India instead of the indigenous tropical stock having been taken in hand; and failure was the natural result. So again with sorghum; Indian agriculturists had tried to introduce all the foreign sorghums, and were doing so to-day, instead of developing their own. The silk industry had been alluded to, and recently he had had occasion to study that subject a little. He did not think the difficulty was in the cultivation of the plant, for the mulberry was probably indigenous to some parts of India; the difficulty had been with the insect. The East Indian Company brought the mulberry-silkworm from China to India, and he was very well satisfied that it was not indigenous to India, though introduced and re-introduced repeatedly. The Indian indigenous silk industry was the tasar; and at the present moment they were rapidly going back to this original industry. The Indian mulberry silk was inferior, not to the Chinese, but to the French and Italian; and it was the immense improvements effected in those countries that had ruined the East India Company's mulberry-silk trade. They could compete with China, but not with Italy and France. But a change in fashion and in manufactures in Europe was giving to India a new silk trade more natural and hopeful for the future, though the change came like a revolution. They could card waste silk by similar methods to that for cotton, and produce an extremely beautiful article. Consequently, India had come back to its old condition; and they were now exporting the waste material from the native reeling-basins, and tasar and other indigenous silks, and, in fact, the principal exports were now in mulberry-silk and wild silk treated as waste. Another article which struck him as worth alluding to was that of skins and hides. Every year India used up or exported nearly 60 million hides of cows and buffaloes, and about 50 million skins of goats and sheep, which represented not merely the slaughter of those animals, because many of them were not slaughtered, but the death-rate. Such figures showed the immense capabilities of a country where such a trade as that could exist. Coal and salt were very interesting also, but, from his point of view, mainly as a means of impressing upon those who were not familiar with India its vastness. It might almost be said that they could not afford to carry their coal or salt to the coast: it was such a gigantic country, and although there were mountains with abundance of salt, they could not pay the carriage to the coast, particularly in Bengal. It was cheaper to bring salt from England, and hence round the coast of India a great portion of the salt supply came from Europe. Before concluding, he

would throw out a suggestion he had long had in his mind, and that was that the day for haphazard experimenting in different industries should cease absolutely, and Indian reformers should now enter on a new era in which they ought to know what they were doing. For that purpose there ought to be a census taken of existing industries, so as to know what position they were in, where they were practiced, and the condition of the people who were employed. That was the first stage, and then, having clearly ascertained what exists, they should go no more to America, to England, or other foreign countries, but turn back on India herself, and develop her own resources in a natural way. It was impossible to expect the people of India—in their present state—to pursue the scientific methods of selecting and perfecting stock. The Government must take the initiative and inculcate the principle of self-help into the agriculture and commerce of India, in place of the old policy of dependence on foreign countries.

Mr. S. J. Wilde said that some few years ago he heard a paper read in that room by a gentleman who said there were no valuable minerals in India, except iron and coal. Since that they knew that an enormous quantity of gold had been found in certain parts, and there were, no doubt, many other deposits to be found in recent years in places where the very best authorities had stated positively that there was none. To the east of the Nerbudda valley they were now actually driving levels for coal under the very part of the plain where geologists said that none could be found, and the same thing occurred in other places. Within the last two years, a company with which he was connected had put down 40 different borings in different parts, and the Government had recently given them a large extent of ground in which to work. As far as he knew, the only metals found, in any commercial quantity, were gold, iron, and coal. Copper was found in some few spots in Bengal, and the Nerbudda valley, but only in small quantities.

Sir C. E. Bernard, K.C.S.I., said:—I agree with what has been said about the interest and importance of the subject. Sir Juland Danvers's paper has admirably focussed the present state of Indian manufactures, and has brought the subject before the Society and before the public in an interesting and complete manner; and we are greatly indebted to him for it. As you, sir, have said that perhaps on one or two points some of us might differ from the view of the reader of the paper, I should like to say that there may be doubt whether the entire removal of all import duties was really to the advantage of India. I am quite sure that, if the Indians had a prevailing voice in managing their own fiscal affairs, India would now be raising some part of her national revenues by import duties, just as every other civilised conntry—not excepting Britain herself—does, and has done. It is impossible to think that moderate duties on imported goods, especially on imported luxuries, could not be advantageously substituted for other imposts, such, for instance, as a part of the salt-tax, which at present levies a duty of 600 per cent. on a necessary of life for the poorest. It is quite true that the future prosperity of India depends very largely on the developement of her home arts and industries. India is big enough, her population is large enough, her productions are various enough, for her to become very much more self-contained than she is. No doubt, the old order is changing in India; old ways are giving place to new ways. But few of us would wish to see the clock of industrial progress put back in India. It is sometimes said by real friends of India that machines, and steam-engines, and machine-made goods, are killing the home arts and the village industries of India; but I venture to think that there is now in India more of industry, and more of industrial art in many directions than there has ever been before, though the manner of those industries and arts have changed. I do not speak of the railways, canals, roads, waterworks, and bridges; those, so far as they go, are confessedly greater than and more extensive than anything India saw in any previous epoch. But I speak of small industries. I believe the change in India during the present generation is that, whereas India's workers used to labour alone, or in very small groups, heretofore, now India's workers are collaborating together, and working in large factories and workshops. An interesting, and, I may say, a gratifying account was recently published by Mr. Lockwood Kipling respecting the town industries of the Punjab. He says the looms for cotton and woollen goods in the Punjab—excepting high-class Cashmere shawls—are busier than ever. The people can afford more clothes, and most of the weavers use Bombay machine-made yarns, from which an exellent stout cloth is woven. Busy carpentry workshops are springing up, where many hands are employed. One workshop gets a name for strong, cheap Persian wheels for raising water; another for light and strong wheels or bodies for the wheels or bodies of the local gigs—*ekkas*, as they are called. It is the same with smiths' work: foundries are springing up, each with its low-powered engines, its lathes, its taps and dies often of local make. The largest of these foundries, owned and managed by local natives, employs over 150 hands, has a steam-hammer on the premises, and last year executed a casting of $1\frac{1}{2}$ tons for the Delhi waterworks. Thousands of iron rollers for sugar-mills go from these native foundries all over the country. It is the same with tin-work and small iron-work: tens of thousands of lamps, and thousands of japanned boxes, are turned out every year at Delhi and Multan. The Delhi lamps go down to Calcutta, it is said, and are sold as of European make. These establishments and these industries would not be possible if there were not railways to carry their products about; and it may be doubted if native iron-work and metal-work would have made anything like such great progress if it had not been for the great railway work-

shops, at which thousands of native apprentices learn the use of machines and Western methods every year. It is the same with tanneries and leather-work. Prodigious establishments, owned sometimes by Europeans, often by natives, exist at Cawnpore, Delhi, Madras, and Bangalore; one of these factories has a yearly output of over 100,000 pairs of boots and shoes. The tailoring trade has been revolutionised by sewing machines, which are employed in vast numbers by the Indians, and with which they now execute elaborate and beautiful embroidery, the demand for which is said to be greater than ever. Jewellery of costly kinds is said to be in smaller demand; but the output of simple yet tasteful ornaments has extended greatly, and these are made at big workshops, instead of at the homes of individual workers. So with copper and brass vessels, the demand for which continues to extend. If this account, as given by Mr. Kipling—himself a true artist and trained observer—is correct, then we may hope that the revolution now taking place in Indian industries, though it bears hardly on a certain number of families for a time, will not be—indeed, whether it is not already—a boon to India. Cotton goods and iron-work are the two great industries which it behoves India to promote and extend during the next twenty years. India produces the cotton on her soil, and she has coal and iron close together under her surface. Already, as Sir Juland Danvers has told us, India produces three-fourths of the coal she uses; but she ought to produce it all, and she ought to become a coal exporting country like Japan or Australia. Countries can and do make very sudden and vast leaps forward in these industries. The United States, for instance, in 1870, 1880, 1890. If Indian railways, Indian water-works, Indian engineers, and Indian ship-building yards, would give a preference to local factories in all their orders for rails, sleepers, pig-iron, rod-iron, and sheet-iron, India would very soon have a very sufficient provision of iron-works and rolling-mills. It might cost a little more a ton at the outset, and perhaps the material might not at first be all of equal merit. But India would benefit in the end; and I believe patriotic Indians would not grudge the small extra outlay, and would recognise that it is not always best, in the long run, to buy in the cheapest market, if such buying stifles or depresses nascent home industries. I believe India would be no loser, even if 100 miles less of new railway were opened yearly, by a steady effort to get her national supplies of iron and iron-work from her own home sources. I should weary this meeting if I were to talk on about Indian pottery work, her stone-work, and her wool-work. She has these entirely, or almost entirely, to herself. And I believe those industries are making steady, artistic, and safe advance. I will only add that, short of vast discoveries of workable gold within her borders, India's true and only way out of the silver difficulty that threatens her with bankruptcy, is the rapid development of her home industries, especially her cotton and iron manufactures.

Mr. J. Athelstane Baines, I.C.S., said that one of the compliments he most appreciated was that of having his conclusions adopted by a gentleman so well-known in the world of statistics, and who had had so large and long an experience of Indian matters, especially those of which he had been treating, and which he had taken so active a part in developing. The ground for the conclusions quoted was, to put it briefly, that the rate of increase of population had been much lower than that observed in any of the standards by which one usually measured the material prosperity of a people, viz., in production, and in the power of expenditure. He would not quote all the statistics bearing on this subject which he had used on the occasion in question, but he might say that the chief ones related to the railway traffic, the use of the post-office and telegraphs, the consumption of salt, the absorption of treasure, and the development of trade, not only in bulk, but in the variety of its directions. With regard to salt, he was rather diffident in questioning what Dr. Watt had said, because that authority had recently paid a great deal of attention to the subject; but with respect to the cost of bringing the salt from the Punjab to the sea, there was no necessity for it, neither was there for bringing salt from Cheshire. There were salt manufactories in the Sambur Lake, Khâraghoda, on the West Coast, and Orissa, on the East Coast, which supplied a very large quantity. That from Khâraghoda would compete with the salt from any of the provinces in Northern India, even with rock salt, and was very greatly in favour. There was also the Ganjam salt, which was now competing with imported salt in Bengal. He made a statement some time ago, to which he still adhered, that the development of the Indian cotton industry in home-made goods had been vastly in excess of the rate of increase of imported goods of the same quality. He alluded especially to grey goods. The increase in ten years of exports of cotton goods of that class made in India was 123 per cent., and of imported goods 13 per cent. He wanted to show the movement, not the quality, and he had been taken to task for not saying that even now the quantity of piece-goods imported from Europe was thirteen to twenty times as much as the whole out-turn of Indian piece-goods. He did not speak of the out-turn, but of the exports, for which there was a large market. The twist and yarn exports, which, in December, he said, was creeping up gradually to the value of the imported twist and yarn, now exceeded it. In December he had used the returns up to the 31st of March, 1891, the end of the census decade, but in the returns for 1891-2 he found the manufactured cotton twist and yarn exported actually exceeded the imported quantity. Of course, Japan was now taking to produce its own, which would cause a certain recession,

but still it was one of the most important sources of revenue to India. The question of silk had been dealt with by Dr. Watt, and it was specially mentioned in the speaker's last paper, because there had been a decrease, but they must not look only to the exports of silk, which was the only portion of the industry for which they had statistics. There was an enormous consumption of small silk goods in India, not, perhaps, so much of large heavy silk goods, but of the borders of turbans, chuddars, and so on, and the silk weavers were a very flourishing class wherever they were settled. There was a special class of goods made in Assam which were familiar in Calcutta, where they were in favour with Europeans for their strength and coolness, and were universally used in the valley of the Brahmapootra, thick ones for clothing, and thin ones for shawls, &c., and he saw no reason to suppose that the silk industry was languishing. Nor was the hand-loom cotton industry. Judging from statistics, it appeared that the number engaged in it had not decreased, but rather the contrary, since 1881, in the southern part of India, whilst in the Punjab, it had decidedy increased. This return might be checked, by finding out the castes occupied in weaving. They knew the names of the castes in the South, where they stuck very much to their own occupation, and he found, comparing them with ten years ago, people came from outside castes to engage in the weaving industry. In the Punjab and the North-West it was different. There the weavers changed their names, and you could not distinguish the castes; as the workman improved in circumstances, he changed the name of his caste, and when that was the case it was impossible to say whether the weaving class as a social sub-division, had increased or diminished. With respect to cotton import duties, he agreed with what Sir Charles Bernard had said—that the duties, if re-imposed, at even a higher rate than before, would be popular, and would not be felt. The importation had increased very much, and the cotton duties had not had the least protective effect on the mills, which were capable of holding their own without any protective aid. The import duties would be simply a matter of revenue. India wanted very much Rx. 3½ millions, or rather more, which they might get from the increased import of cotton piece-goods. Whether they would get it or not, depended on circumstances, not in India, but at home. He could only say that India wanted it, but one must say, in common fairness, that the present state of trade in Manchester was not such as to justify a Government in re-tracing their steps. It was much more sensitive than the industry in India, and was at present suffering from a reaction. With regard to the jute trade, he had heard that for the last year or so it had been depressed, but it seemed to him that with the enormous labour-market round Calcutta, with the vicinity of the coal, which could be had at less than 5 Rs. a ton, from within 100 miles, there was no reason why this large increase of manufactured jute, which was last year temporarily stopped, should not go on when circumstances returned to the normal condition, until a great deal of the trade that now went to Dundee was carried on in or near Calcutta. One common mistake made was in underrating the enormous resources of labour power in India. The Indian operative was exceedingly docile, abstemious, and industrious, if not energetic. He had every qualification for making himself an exceedingly useful member of society. All the industries they had heard of as having increased largely were those principally recruited from the lower strata. The articles of unproductive expenditure were now supplied to the richer classes in just the same relative quantities that they were before, though the absolute out-turn was probably less. The Courts, which had supported them so largely were now become, where they existed, much plainer in their tastes, and expended less. The premier Court in India, that of the Viceroy, came down to Calcutta with a large train of officials and servants, and then left Calcutta for five or six months, but its exodus left not a trace of a ripple on the stream of Calcutta commerce, and made not the least difference to a single person in Calcutta, except those who were interested in purveying the food and luxuries required by that class, either there or at Simla. The kernel of the whole question lay in the development of the common industries of a country by means of its own capital. All these industries, of which leather was an extremely good example, were being developed by foreign capital. Five or six years ago there were some unfortunate disputes in a certain town in England, which led to disagreements and difficulties in fulfilling contracts. The hour was come, and the man appeared. It was probably the same individual to whom Sir Charles Bernard alluded. English capital was transferred to India, chiefly to Cawnpore. A few lakhs of rupees were spent in making this concern good. Leather workers, the lowest of the community in the North West Provinces, were largely enlisted. European modes of tanning were introduced, and he believed contracts for between 180,000 and 250,000 pairs of boots were now given to that manufactory. They were coining money hand over hand, and the interest accrued in India. Then came the question what was to be done with that interest when the promoters had made a fortune and wanted to come home again. There was a great deal of money came home every year to be invested, but there was a great deal invested in India as well. The great benefit to the country would arise when they managed to tap what was known to everybody to be an enormous hoard in both small and large savings in India. They had heard of the 130,000,000 rupees which were found in the four cellars connected with Scindia's bedroom, in earthen pots, and sewn up in rotten bags. That was an exceptional case, but there were other hoards, not only in the native States, not as big, but on the same principle. Scindia was

nearly caught in the Mutiny. He had a warning which lasted him his life, and he was fearful that the same things might occur again. Almost every banker and native money-lender in India had a hoard somewhere in an iron chest, under a floor or down his private well, and it did not come out except on very rare and grave occasions. In the famine, immense amounts of valuable and artistic ornaments had to be brought out. There was no reason why, if they could implant confidence in the people, these hoards should not be invested remuneratively in India. One of the obstacles seemed to be that the development of industry at present seemed to be all on the lines of the lowest castes. It was their horn that was being exalted; they were now gradually acquiring a position they never had before, and never would have had except under British rule. The perfect equality of the lowest classes before the law gave them the opportunity of rising in social position; they spent more on their marriages, and imitated their superiors in every way, as they had a right to do. Until the British rule established this general peace with a strong hand, there was no sense of security. A man might be brought to grief in a day by the will of the ruler, and the idea of equality before the law was absolutely abhorrent to all the upper classes. There was a song about Delhi, just after the Mutiny, that all these troubles had come to pass, and must come to pass, when the chamar, the woman, and the boy were considered equal with the man. These industries had been fostered by and for the lower classes, and one of the grave questions which had to be considered was whether the confidence which was required for commercial enterprise was not that of the middle classes. They knew the upper classes of the trading community were very enterprising, but what they wanted to get hold of was really the middle classes generally.

Mr. C. Purdon Clarke, C.I.E., said that he could only speak with reference to decorative industrial arts, and he would confine himself to an expression of opinion, that after some 13 years' experience, and study of the question, he could not come to any other conclusion than that their chances of ever becoming an export trade were very small. Dr. Watt had saved him what would otherwise have been a long argument, by explaining how we had successively destroyed many valuable indigenous Indian manufactures by attempting to ingraft foreign materials and methods, and were obliged afterwards to begin over again, taking them up in the old native fashion, and by trying to develop them on native lines. The same could be said of the decorative industrial arts, which, at present, were nearly all destroyed. On his first visit to India he tried to find traces of the old factories spoken of by historians, and so ably described by Sir George Birdwood. At Rondere, in Surat, at Masulipatam, and at Tanjore in the interior, he found, still surviving, several factories working for foreign export. At Rondere, in Surat, they were weaving, for the Burma and the Siam trade, curious kincobs and heavy gold brocades. At Masulipatam, on the opposite side, there was still a very important trade with Persia, but in both cases it was a declining trade. They spoke of times 40 or 50 years ago, when a ship was chartered every year to take the year's produce to Persia or Burma; but that was a thing of the past. But, to their credit, they had made no attempt to keep the trade going by lowering the quality and degrading the art; they were content to die honourably. He was sorry to say that in every art we had encouraged there they had simply answered our demand for cheapness, and soon found that we would take any rubbish provided it was wrought all over with any kind of ornament, however meretricious or meaningless. This demand for rubbish, at a cheap rate, had been met. The Hindu workmen were not responsible for it, but the Parsee traders, who knew nothing of the matter, and only looked upon Indian art-ware as they would upon cotton bales or drugs, with the result that at the present time there were in London, Paris, Vienna, and New York, large accumulated stocks of rubbish —sham printed cloths, sham metal-work, sham jewellery—the real produce of India, but having no more connection with Indian art than if they were made in Birmingham.

Mr. Martin Wood wished to say one word on behalf of the Bombay side. Sir Charles Bernard and Mr. Baines had referred to the encouraging progress of manufactures in the northern provinces, and he should like to mention the establishment of the Industrial Association of Western India, which had held two or three Conferences, and published a quarterly review. In that review for last October there was a list, supplied by Mr. O'Conor, of the articles which might be made in India but were imported instead; and almost every aspect of the subject referred to that afternoon had been treated in that serial. He hoped those who wished to follow up the subject would consult it, or the notices of it that appeared from time to time in the *Indian Magazine and Review*. The patience and perseverance with which these men of Western India were following up this subject was exceedingly gratifying, and ought to elicit some practical assistance on this side. There was, of late years in India, a spontaneous, active, energetic movement in this direction, which was energetically conducted, but which would be all the better for assistance and encouragement, and Sir Juland Danvers's paper and the present discussion would tend in that direction.

Sir George Birdwood, K.C.I.E., said that he could not prolong the discussion at that late hour, and would only express his respectful concurrence in the ecomiums passed on the paper read by Sir Juland Danvers. He had had the great privilege of serving with him in the India-office for the last twenty years, and they all there looked up to him and Sir Thomas

Seccombe as the greatest ornaments of the Indian Home Service. They well illustrated the insight, impartiality, and sound judgment with which the Court of Directors selected their servants; and among all the competition-wallahs now in the India-office there was not one he could look forward to as likely to earn, in his official career, so solid and well-deserved a reputation as these two gentlemen. Mr. Baines was the only one in the discussion who had properly distinguished between handicraft arts and commercial industries. He could not speak of commercial industries with any authority; it was only the arts of India he had studied, and the hour was too late to attempt to speak on them in the present connection. With regard to commercial industries, India would always be able to hold her own, as she had done from the earliest times. He feared no competition with India, and was perfectly certain that, in the process of the years, India would do everything she wanted for herself, and beat all European competition out of the Indian Ocean. India was the largest area of tropical soil throughout the whole world open to the industry of man. Owing to the narrowness of the peninsula in proportion to its length, only a very small portion of it suffered from its solstitial position, namely, Rajpootana. To this vast fertile area was applied the patient labour of an agricultural population of over 300,000,000, who, through at least 4,000 years, had learned to exactly adjust themselves to the conditions of their existence, and knew, far better than we could ever teach them, how to turn those conditions to their highest advantage, not only material, but social and religious. In short, India was one of the great fountains of the commerce of the world, and had been from the earliest antiquity, as he had developed in great detail in the introduction to a volume of "The Records of the India-office," recently published by Mr. Quaritch. And India would remain so to the end of time, and he was perfectly certain the people of India never need fear the industrial and commercial rivalry of any other people in the world.

The CHAIRMAN said it was too late now to speak at any length, and Dr. Watt, than whom there was no greater authority on the commercial and industrial products of India, had already dealt with two or three points which he should have touched upon, and in a far more able way than he could have done. He entirely agreed with him that we had wasted time in going from the indigenous to the exotic, but we were getting more sensible now as we gained experience, and were now more bent upon developing the natural resources of the country, than trying to import Western and other so-called improvements. It was not only in the natural products of the country that the introduction of the Western element had been pernicious, but also in the manufactures. For instance, in the carpet manufacture, 30 years ago, when he was stationed at Mirzapore, one of the principal centres of the manufacture, which was in native hands entirely, before the gaols of India had absorbed a great deal of this class of work, he took great interest in these carpets, and noticed that the dyes were unsurpassed by anything which could be produced in Europe. For years he had visited the native looms, and had seen the gradual falling off in this trade, and the reason he believed to be this. The customer had been an enemy to the industry. He had insisted on colours which did not belong to the native dyes, and on patterns foreign to the native beautiful taste. Consequently, foreign dyes had to be introduced, and the old patterns distorted. The natural result was, that the native, finding he could obtain a dye which was more popular with his customer, very much less trouble, and at an infinitesimal amount of expense, followed the pernicious system, and the Mirzapore trade in carpets, although it increased in volume, had lost all its old purity and value. With regard to silk, Dr. Watt had expressed the idea that India could hold her own with China, and Mr. Baines also alluded to the fact that we had very few records of the quantity of silk produced in India, because the mulberry silk which was reeled was consumed by small looms all over the country, especially in the Benares district, of which there was no record. As to the present position of the jute manufacturing industry, he should say it was healthy. The first mill was erected on the banks of the Hooghly about the end of the fifties, but that river was now studded with factories for a distance of 30 miles. In fact, Dundee had been lifted from the banks of the Tay and planted on the Hooghly. It was but a natural result, that an article produced only in Bengal should, instead of being carried to Great Britain to be manufactured and brought back again, be turned into manufactured goods on the spot. Like cotton and other industries, they had been apt at first to overdo it by bringing so many mills together that the production rather exceeded the consumption. Bombay had suffered in this way from a plethora of cotton mills, but as time went on, consumption overtook production, and once more they got into a good paying time. There were many other industries, such as the shellac manufacture, which employed a large number of natives. He rather took exception to the figures given by Sir Juland Danvers as to the proportion of agriculturists, because they were somewhat misleading. The agricultural class took very largely to other work; for instance, coolies on the railway were all described as agriculturists, and many of the same class also worked in jute and cotton mills. Wherever an industry had been introduced there was no difficulty in finding labour, although in some instances it had been converted from a class which did not formerly follow it. The point referred to by Mr. Baines, in his concluding remarks, was of the most vital importance, and he was sorry to say he could offer no solution of the difficulty, which was how to get the natives themselves

to invest their capital in the industries of the country. The bulk of the Government paper, amounting to 87 per cent. of the whole, was held by European capitalists, showing that the native had not yet got sufficient confidence in the country to invest his money in the bonds of that country, and it was the same with manufactures. It was recently stated in the House of Commons that the capital invested in commercial enterprise in India, excluding railways, was 200 millions, and he believed that was no exaggeration, and this only added force to the remarks of Dr. Watt as to the vast resources of a country when it could take in that amount from outside, while still having its own hoarded millions free for employment. He concluded by moving a hearty vote of thanks to Sir Juland Danvers.

This was carried unanimously, and the meeting adjourned.

Mr. EDWARD J. WATHERSTON writes:—It will not surprise any one who knows me to learn that my interest in Sir Juland Danvers's most interesting and instructive paper centred in that part which referred to the silver plate industry, its past and present condition, and its prospects, as a result of the abolition of the plate duties, and the slight alterations made to the hall-marking laws, in this country. It cannot be denied that the abolition of the duties has been of immense service, as far as our home trade is concerned. The output, as regards weight, has more than doubled. As regards quantities, it must have increased five-fold. Wages have risen, and there is an increased demand for skilled labour. It must have had, also, a beneficial effect as regards India, judging by the very large exhibition at the Imperial Institute, referred to by Sir Juland. But I still adhere to the opinion, expressed so often at the Society of Arts, viz., that no great results can follow the abolition of the duties until hall-marking has been made a voluntary institution, until the principle of compulsion has been completely abolished; neither can India avail itself, to the full, of our market, nor can our home export trade expand to its utmost limit. Her Majesty's Commissioners of Customs still interfere with imports from India by delay. Agency charges, and risk of damage by handling and repacking at the Customs, still affect Indian manufacturers and merchants, and prevent, if not prohibit, that enterprise which can alone result from complete freedom of trade. India has a right to complain. I send a box of plate to Calcutta, and it is delivered unopened at its destination. An Indian manufacturer sends me a consignment. It is opened; I have to pay agency charges, and if, in the opinion of Her Majesty's Commissioners of Customs, it be of Oriental design, then it is delivered to me handled, and very probably injured. If it be not of Oriental design, all foreign plate must go to Goldsmiths'-hall, there to be scraped, assayed, and marked, and to be injured past hope of recovery. As regards our home trade, I fully admit that it has increased, but our export trade has not, and never will until compulsion has been abolished, foreigners neither wanting our standard nor our hall-mark, and our laws absolutely prohibiting the manufacture of unhall-marked plate, whether for home use, or for exportation. It must, therefore, be of ·925 fineness, a quality not wanted by any foreign nation under the sun, save America, and that country, at present, bars all progress, save its own, by an *ad valorem* duty of 45 per cent. There is no hall-marking law in America. It, therefore, behoves all persons connected with India to do all they can to get the Board of Trade (already convinced of its desirableness, as proved by the evidence of Sir Thomas Farrer and Mr. Giffen before the Select Committee of 1878-9) to reform the Hall-marking laws, under a firm conviction that the interests of India will not be in conflict with the best interests of the United Kingdom. Under a voluntary system, hall-marking will be as general in this country as it now is under compulsion.

NINETEENTH ORDINARY MEETING.

Wednesday, May 3, 1893; W. H. PREECE, F.R.S., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Perceval, Westby B., 13, Victoria-street, S.W.
Prater, Thomas Herbert, Parlington Estate-office, Aberford, near Leeds.

The following candidates were balloted for and duly elected members of the Society:—

Cole, Robert Langton, 2, Shorter's-court, Throgmorton-street, E.C.
Wrigley, Norman, 10, Brunswick-gardens, Campden-hill, W.

The paper read was—

PRACTICAL ELECTRICAL PROBLEMS AT CHICAGO.

By PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S.

It is not the object of this paper to traverse beforehand the topics which are to be submitted to discussion at the Electrical Congress to be held at Chicago three months hence. The opinion of that Congress is to be taken upon certain matters of utmost importance,

such as the final adoption of international units and standards, as well as other questions of nomenclature which are of international convenience. To attempt to forestall the decisions of the Congress on these or other matters, by raising a discussion on them here, would be both ill-timed and discourteous. My object is entirely other. It is, in brief, to draw your attention to a number of matters which are at present engaging the notice of electricians, matters which are, for the most part, on the verge of scientific progress, matters partly within and partly without the range of the practical electrician. From that border-region, just outside the limit of actual commercial practice, must inevitably come the next advances in the industry. Every one who is familiar with the history of inventions knows how it is that, before any great world-compelling invention takes practical form and shape, it is more or less consciously existent; it is "in the air;" the pioneers are alive to its possibilities, though they may be accounted but as dreamers of the unpractical. Discovery, of the abstract order —often unrecognised as to its importance, yet none the less pregnant of result—almost invariably precedes invention. The task of reducing to serviceable form, fit for use, the newly-discovered abstract truths is the problem before the inventor, who, indeed, may be both discoverer and inventor in one, the pioneer both in science and in industry. Of late there has been a lull in electrical invention. Not that the footsteps of inventors have ceased to dog the Patent-office, or that the streams of outflowing specifications have been dried up. It is the quality, rather than the quantity, of recent electrical inventions that has declined. Those eventful years, from 1873 to 1883, which may be said almost to have created the modern electrical industry, saw the introduction of many radically new inventions, many really novel departures in the application of science; and the very fertility of that harvest of invention seems to have, for a time, exhausted the soil.

But the apparent pause in the progress of events is the real time for the progress of ideas—the epoch for the incubation of new suggestions. Once the new ideas have taken form and growth, the development from them of new inventions is a logical certainty. The new inventions must and will come. We seem now to be approaching the close of the period of lull; and the new ideas that have been gradually spreading and rooting may be expected to crop up in invention. We seem to be treading on the verge of new methods, new appliances, new results.

At such a time, as circumstances have decreed, we are to meet our electrical brethren, not only of the United States—that home of free ideas and unbiassed progressiveness—but also of other countries, in friendly converse as to the progress of that art and science in which we are most interested. We shall rub shoulders, and exchange views and opinions with them, discuss our special varieties of practice, our special points of experience, our expectations, and hopes and doubts. We shall have much to learn from one another; and, in the amicable rivalry of nations, we shall all be keen to make the most of our opportunities.

What, then, are the points that will interest us most? What are the burning questions that will awaken our attention?

Let us begin with some more sternly practical questions that confront the electrical engineer. The methods of working that prevail in the matter of electric light and power present many points of divergence between different nations. One cannot help raising the inquiry why these divergences exist, and whether amongst them there is not a best way to be chosen? Let us consider them in detail.

Not only do we find divergences in the types of generating plant in habitual use in central stations, we find differences in the modes of distribution, even in the methods of house-wiring, differences which are not mere matters of taste or fashion. In the average English central station, the dynamos are few and massive, and, for the most part, are mounted so as to be direct-driven each by its own separate high-speed engine. Belting and countershafts are conspicuously absent. In the average German central station, though both engines and dynamos differ in type from the English, direct-driving is almost universal. The main difference—as between British and German practice—is, that in England, where land is dear, we build compact high-speed dynamos, and design special engines to suit them; whilst in Germany, where compactness is no great advantage, large slow-speed multipolar dynamos are designed to suit the large slow-speed engines. Contrast with this the average American lighting station. The dynamos are not designed for the engines, nor the engines for the dynamos, and neither of them is specially designed for the particular station

where it is to be erected. Both of them are, so to speak, taken from the stock of some particular factory; and as the dynamos are comparatively small, numerous, and high-speed, whilst the engines are few, large, and of slow speed, being ordinary factory or mill engines for the most part, engines and dynamos cannot be coupled direct, but must be geared by the intervention of countershafts, pulleys, and belting. Not that there are some fine exceptions; for example, the Elm-street Edison Station in New York, the machinery of which was designed by Mr. Van Vleck, after a tour of inspection in Europe. Also some recent large combined plant of the Westinghouse Company. But for the most part, the leather belting is the one conspicuous feature of an American lighting station. Take, for example, that of St. Louis, Missouri, the largest arc-lighting station in the world. The engines are ten in number on the ground floor. They are single expansion engines of the Corliss type. The dynamos, 53 in number, are on the second floor. The whole of the first floor of the building is given up to a magnificent array of long-countershafts, carrying some 70 pulleys, and leather belts, receiving power from below, and transmitting it to the floor above. Our cousins evidently believe in the truth of the adage that there is nothing like leather. We have absolutely nothing to show like this on our side; the nearest approach being the Westinghouse Station of the Metropolitan Company at Sardinia-street. This is an alternate current incandescent station, with all the engines on the ground floor, and all the dynamos on the floor above.

That it may not be said that I am giving, as an example, an old station, built in the dim and distant past of 1891, let me set alongside the St. Louis example the very latest one that came to hand but two days ago in the *Electrical World* (New York) of April 22nd, 1893. Therein is described the new central station of the city of Akron, Ohio, where there are four compressed condensing engines, and seventeen dynamos, all belt-driven, and all on the same floor.

Compare this with such stations as ours of Manchester-square, or of St. Pancras, or the stations of the Westminster Company, or of the Kensington and Knightsbridge Company, or those of the St. James's Company. In none of these is there any countershafting or belting. Nor is there in the new Glasgow station. Nor will there be for the new machines of the City of London Electric Lighting Company, at Bankside, though, in the temporary and transition plant, rope-driving without countershafts has been employed. Not that I would dispute that there are advantages in driving by the aid of belts. The method has the obvious advantage that, if a bad short-circuit occur, the belt is thrown off or broken before any other damage is done. In other words, it prevents armatures which are of inferior mechanical construction from being destroyed by an accident which ought to have been entirely impossible of occurrence.

Not only in the matter of direct driving, but in the whole design and construction of station switchboards, does practice diverge. The British engineer desires to have everything as solidly simple as possible. His ideal is simply a pair of omnibus bars, into which all the dynamos feed in parallel, and from which all the feeder mains run off to the various circuits of the distribution. In some cases he falls short of this sweet simplicity, especially in those stations where a battery of accumulators is used, but that is what he desires to attain to. The American switchboard evinces an almost equally strongly marked ideal: the desire being to divide up the circuits and the generators into as many separate units as possible, while retaining the possibility of connecting up any one of the dynamos singly with any one of the separate circuits. The most recent and elaborate of such switchboards, resembling in the quantuplicity of its parts the multiple switchboard of a Telephone Exchange, is figured in the supplementary issue of the *Electrical Review* (New York) for Feb. 25, 1893. It is the switchboard specially designed for the Manhattan lighting station, and is so contrived that, with seventeen circuits, and nineteen dynamos, by no possibility can any two of the dynamos be put into parallel with one another.

Practice differs again in the mode of distribution by mains. An electric light pole, and having a transformer hung on to it, where it brings the current to your house, is a sight which cannot be seen in England, simply because it does not exist. Our transformers are almost always put in fire-proof cellars, and our mains run underground in conduits instead of overhead on poles.

In house-wiring, too, practice differs. The wooden casing that, thanks to the fire-office rules, is almost universal in England, is by no means universal elsewhere, and, in some countries, is almost unknown. It is probably destined to disappear in time, when safer modes of carrying wires are recognised.

Wood-casing has three grave defects—it is neither damp-proof nor incombustible, and, too often, it covers, like charity, a multitude of sins. In this connection, it is important to note that, in spite of the curious predilection of so many of our fire-offices toward the use of wooden casing, the proportion of electrically-caused fires in this country is extremely low. This satisfactory circumstance must be attributed, not to the general use of wood-casing for house-wires, but rather to the very wholesome dread inspired by the vigilant and able surveyors of the chief fire-offices, of whom Mr. Musgrave Heaphy is the most eminent, and who have, in spite of the curses so frequently showered upon their heads, insisted upon the prime requisites of good material and sound workmanship in all risks that they undertake to insure. If their requirements have seemed, in individual cases, hard or arbitrary, they have done incalculable good in stamping out the inferior work of scamping contractors. It is an open secret that some of the New York fire-offices have become of late very uneasy about the increasing prevalence of electrically-caused fires. It is even stated, though I cannot name my authority for the information, that some of them have recently sent representatives to this country to learn how we manage to keep electric lighting safe. Doubtless we shall, at Chicago, exchange opinions on many of the details of this highly practical question. What is wanted is a mode of running the wires and fixing the switches and other accessories that shall not only be electric-tight, but shall also be water-tight, gas-tight, air-tight, oil-tight, fire-tight, and rat-tight.

Upon the question of the degree of incandescence at which it is most economical to run glow-lamps, we shall probably find differences of opinion. It is obvious that the "smashing point" at which it pays to destroy old lamps depends upon the market-price of lamps—a factor of the problem which is just now of a very uncertain nature. Whether Mr. Westinghouse's "stopper" lamp is made a commercial success or not, it is clear we are on the eve of a great revolution in the price of lamps. When they are really cheap, we shall give them short lives and merry ones, working them while they last at a higher degree of brightness, and, therefore, of efficiency.

Another battle of opinions, that will doubtless break out, will revive old controversy as to the relative merits of alternating and direct currents. The advocates of accumulators will come armed with the latest statistics to support the direct current, whilst the advocates of alternate currents will be challenged to produce practical motors that can be put upon their circuits. The great success of accumulator stations in England will doubtless whet the curiosity of our brethren, and inspire them to point us to some still greater success of some other system on their side. It is very singular to remember in this connection that, at the Philadelphia Exhibition in 1884, there was not a single alternate-current dynamo shown—there was not, indeed, a single one in existence in the States; all machines at that date being for direct currents. Contrasting that epoch with the present, the growth of alternate-current systems to their present development seems truly remarkable. For now we have not only to discuss the general merits of alternate-current, as against those of direct-current systems, but the relative merits of high-frequency, as against those of low-frequency alternations; the merits of high-voltage, as against those of low-voltage systems; and the merits of three-phase and four-phase alternate-current systems, as against the simple ordinary two-phase alternate current system. Possibly, many of us are becoming tired of the eternal *drehstrom* question. The three-phase, high-voltage, long-distance transmission from Lauffen to Frankfort, eighteen months ago, was a magnificent *tour de force*. It showed what could be done. The generators of that splendid experiment are still running to illuminate the town of Heilbronn. But it must be confessed that even here the three-phase system has remarkably little to show of advantage over the universal two-phase system. The complications it introduces, by its substitution of three wires for two, are not compensated for by any great gain. The supposed advantage that it permits the use of self-starting non-synchronous motors is, apparently, illusory; for it is clear that if the problem of giving us a satisfactory alternate current motor, suitable for use on an ordinary two-phase circuit, has not been solved by Messrs. Hutin and Leblanc, it will be solved by Messrs. Stanley and Kelly, or by the engineers of the Oerlikon Fabrik, or by Messrs. Brown, Boveri and Co., or, perhaps, by all of these able engineers, in as many different ways. As for any supposed superiority in other respects of a three-phase or a four-phase motor over a two-phase one, it is merely a question of plant-efficiency and of comparative unimportance.

Much more attention will, probably, be given

to the battle of the frequencies. Very low frequency currents will apparently serve certain purposes that will make them of special use in particular cases. Many years ago, M. Abdank proposed to use them for telephone signalling, and to replace telephone batteries. On the larger scale, though excellent for operating motors, they are distinctly bad for arc lighting. In the processes of simplification in central station work, we want to be able to run the arc and incandescent circuits off the same simple pair of omnibus bars. If this ideal is ever to be obtained—and Mr. Ferranti tells us it is within our grasp—we shall have to keep up the frequency of our alternations, not lower it. In the other extreme direction we have had a most enticing field opened out by the researches of Mr. Tesla, and of Prof. Elihu Thomson, upon very high frequencies. The strange properties of high frequency discharges when supplied at very high voltages raise new problems. We want, as a new invention, a frequency-raiser; an organ, which shall transform the frequency, even as the induction-coil transforms the voltage. The frequency-transformers hitherto used in the laboratory for purposes of research—namely, the Leyden jar and Herz oscillator—are not practical for electric-lighting purposes. The phosphorescent glow of the novel high-frequency, high-voltage, high-vacuum lamps that Mr. Tesla promises us, costs, as yet, much more, for equal quantities of light, than any other form of electric illumination. Who will make the new departure that will bring such lamps within practical range?

We shall discuss high-voltage, too, from another point, namely that of the utilisation of Niagara, and other natural sources of power, by permitting of the economic transmission of power to long distances. Ever since 1879 this dazzling possibility has been before us. We may yet see Lord Kelvin's 80,000 volt transmission an accomplished fact. The three suggestions made in that year, to attain an efficient high voltage, have all been tried. Professors Ayrton and Perry's was to run the dynamo and motor both at a higher speed. Professors Thomson and Houston's was to put several dynamos and several motors in series. M. Achard's was to work with more powerful magnets in the machines. All three suggestions have their good points. They have been tried at Munich, at Creil, at the Gare du Nord in Paris, and notably at Frankfort; but they have also been put into practical use, by the aid of transformers, in scores of other places, and are at work to-day. What shall the next step be? Perhaps, at Chicago, we may hear from Professor Forbes exactly what is to be done at Niagara.

Closely connected with power transmission comes the problem of the electric railway, and the question of rapid transit by electrical mean. Several thousands of electrically-worked tramway lines throughout the length and breadth of America attest the extraordinary progress of recent years. And if America cannot yet show one single electric railway on the scale of our City and South London line, it is probably because she has some great surprise in this direction in store for us, and will throw our present advantage in this point into insignificance. Subsoil roads are certainly going to revolutionise the cross-traffic of all great cities. But will not America show us something much bigger and more daring than our little six-mile pair of tunnels from King William-street to Stockwell?

The applications of electricity to mining must also come in for discussion, and many other engineering applications. Many engineers are now alive to the possibilities of electro-magnetic mechanism. Friction clutches are being superseded by magnetic ones; and a recent suggestion of Mr. Edison is to increase the grip between belts and pulleys, by the introduction of magnetic adherence between them.

Turning from the problems of heavy engineering to those of lighter electrical appliances, there are still matters innumerable awaiting discussion. We shall have the new "telautograph" of Professor Elisha Gray to admire. We shall canvass the probabilities of its adoption and development as keenly as we did, nearly 20 years back, those of the telephone. It is a matter of congratulation that Dr. Gray, who at that time was somewhat cruelly pushed aside, in the pressure of events, from receiving his due share of recognition for the part he played in the early stages of telephonic progress, should now have made such an apparent success with the later creation of his inventive brain. The cruder tentative autographic telegraphs of the earlier workers cannot be put into the same line as the wonderfully perfect instrument which will assuredly be one of the features of the Chicago show. But there are other battles to fight in the telegraphic field. Our system of rapid automatic transmission, originated by Wheatstone, and perfected steadily and surely under the hands of the

British Postal Telegraph Department, has not yet superseded all the older and slower forms of telegraphic instruments, even on those lines where press work and heavy commercial work demand the most perfect and efficient instruments. It is strange that in the United States, where such commercial considerations are deemed quite as important as they are with us, the adoption of the rapid automatic system should have been so slow. American telegraphers were not one whit less quick than we to perceive the advantages of duplex and of quadruplex working. In respect to quadruplex, though Europeans worked out both duplex and diplex, and had shown that, by combining them, a quadruplex transmission was possible, it was yet left to American electricians to put it into service, and to devise the practical combinations for everyday use.

The problem of the fuller utilisation of telegraph and telephone lines takes fresh importance every year, as traffic thickens, and the possibility of adding new lines beside those already darkening the air is narrowed down. Rapid automatic transmission is, for many purposes, a far more efficient service than the quadruplex. Then there is the question of harmonic duplex and multiplex telegraphs. There is the problem of multiplex service by the distributing device of Delaney, which is already being tried in the British Telegraph system. At Chicago, we shall see the phonopore doing service not only as a harmonic duplex, but also for providing a telephonic service upon the railway signal lines to keep up communication from cabin to cabin of the block system. This ingenious adaptation of devices has received, since its inception by Mr. Langdon-Davies, numerous improvements in detail of late from that ever active veteran telegraph engineer, Mr. Spagnoletti, and I am told that the instruments at Chicago will also embody the results of some suggestions made by the officials of the British Post-office when the instruments were tried there.

The rapidity of signalling through cables is a matter which our President of to-night—the official representative of Great Britain in matters electrical—has given much attention. He has shown us what careful design may accomplish in the matter of the telephone cables from England to France and from England to Ireland. The next step will be to show that it is possible to talk by telephone through the 120 miles of sea that separate England from Holland. There is not the least reason why that should not be done within the next twelve months. This is a matter to which recently I, too, have been giving some attention; and it is perfectly clear to me that, by taking into account the action of electromagnetic induction in diminishing the retarding effects of capacity, and utilising that property rightly, it is only a question of time and money to effect telephonic communication through even an Atlantic cable. It is possible that at the present moment no two telegraph engineers would agree on the right way to carry out the thing. Few, if any, would deny the abstract possibility. It affords a splendid field for discussion. Above everything we want a few suitable hard facts of experiment as data to base argument and calculation upon. What seems certain is that there will be no more Atlantic cables built on the old plan, with a single conductor enclosed within an external armouring of iron. That type of cable is doomed for all rapid work. Long-distance telephony is no mere dream. Nor is hekto-plex telegraphy. And telegraphy without wires is already, in isolated cases, an accomplished fact. Seeing by electricity, in spite of the telephonoscope which graced the Jubilee *soirée* of the Postal Telegraph-office, must be left to the twentieth century. We have problems enough to discuss at Chicago without entering upon that enticing phantom.

I have not time to enlarge upon electrochemical themes; but we have many projects ripe for discussion. New methods of recovering and refining metals. The use of electricity in the preparation of chemicals, such as caustic soda, for the rectifying of oils and alcohols, and for the production of chlorine, ozone, and bleaching liquors. The application, too, of electricity to hasten tanning, and other similar processes of electric osmose, deserves careful discussion. Electrolytic synthesis is an almost unworked line of investigation, and ought to be as fruitful as the electrolytic analysis that underlies all the plating and typing processes.

Those of us who may enjoy the benefits of a trip to Chicago will, it is clear, have to encounter a perfect tornado of electrical ideas. We go to mingle with our brethren of the electrical craft in friendly converse, as admirers, let us trust, rather than as critics. On whatever points of practice we differ we may be sure the advantage is not all on our side, and shall be ready to give a hearty

appreciation to, and to enter into an intelligent understanding of the causes that produced those differences of practice, even when they are differences that tell against ourselves. There are moments when one would wish to dispossess oneself of the critical faculty and instead acquire an unlimited capacity for admiration. The Exhibition itself will give us much matter for genuine admiration : the Congress will equally furnish us with food for thought. The country which produced a Franklin, a Henry, and a Morse, is happily still rich in citizens of distinction in electrical science : for it can boast a galaxy of names as eminent as those that can be produced by any country in Europe ; as eminent not in abstract science only, but also in the work of pioneer investigation, and in the genius for utilising the forces of nature for practical ends.

DISCUSSION.

Prof. Ayrton, F.R.S., said the paper contained so many points that it was impossible to discuss them in detail. It occurred to him, when he heard the long programme of questions to be brought forward at Chicago, that he had omitted, when taking his return ticket, to inquire how many years it was available for ; for if all these points were to be thrashed out, he thought the English visitors would not be able to return during the present century. He could only congratulate the author on having got together such an admirable list of subjects for disputation.

Mr. A. Siemens said that the machinery in the American central lighting stations was simply taken from stock, and therein lay the great advantage to the manufacturer, because he could produce all his machinery on a large scale, and could, therefore, do it at a cheaper rate ; and thus the problem was rendered much easier. In England, the practice was for the Town Council or the company to issue a specification drawn up by a consulting engineer, and the manufacture got a document of many hundred pages, in which every bolt was prescribed, and if he asked the engineer if he might not use three-quarter bolts instead of a five-eights, because then he could take them from stock, he said, "No ; you must make it exactly as it was designed." Consequently, though there was a family likeness, every station was different from every other, and no manufacturer dared stock a particular size machine, because the next engineer he had to work for would prefer it one-eighth inch higher. The English and German practise of coupling the dynamos direct to the steam-engine was much better than belt-driving, as was sufficiently shown by the photographs of American stations, with their wilderness of belts. There was no advantage in a belt preventing damage to the dynamo, because a good dynamo, if short circuited, ought to be able to pull up its steam engine without damage to either. The English switch-board, also, was preferable to the American system, under which, if anything happened to one of the dynamos, the circuit connected to it was out, and an interruption took place ; in the English system, an accident or failure in one part of the system was of less consequence. He concurred in the condemnation of wood-casing, which required very great care to produce good results ; and he had lately fitted up an installation with no casing at all, except where the wire came within reach. He did not agree with Prof. Thompson in calling the ordinary alternating current two-phase ; the three-phase current had, in one period, three positive impulses, at 120° difference in time, while the ordinary alternating current had only one ; so that, if this were called a two-phase current, the other ought to be called a six-phase.

Mr. F. Bailey said it was matter for congratulation that England would be so worthily represented at the Electrical Congress at Chicago, if she were surpassed by other countries in some of the other departments of the Exhibition. With regard to the practice of using belting, both in America and at the Sardinia-street station, he might remark that only American belts were found equal to the work. The driving angle was more acute than any English belting would stand, and the greater flexibility and adherence of the American belts was really surprising. Although the author had criticised very fairly the American practice in some respects, it did not at all follow that they would not do better if they had the chance. They did far more work than we did, but there was no doubt that if they could they would prefer to use larger machines, and employ direct driving, and the Westinghouse Company had made some splendid specimens of that type. They confessed that they had a great deal to learn from this country, whilst, on the other hand, there were some points in which we might learn from them. American visitors were very much struck with the enormous extent of underground mains in London ; they had nothing like it in the American cities. Not long ago the Westinghouse Company seriously took him to task for suggesting that wires might be laid underground, enclosed in rubber tubes, but he was convinced that when they once went into it the wretched overhead system would soon be put an end to.

Mr. H. L. Webb was rather disappointed to find that the questions he hoped would be discussed were deliberately avoided. He believed that those who were organising the Congress were anxious that the questions of units, nomenclature, &c., should be discussed before the meeting, and a reasonable

amount of the preliminary work done, so that the Congress might have as little as possible of the thrashing out proceedings to go through. With regard to the electric lighting plants, the work in America was done in an entirely different manner. There the consulting engineer scarcely existed. When anyone thought of doing anything in the way of electric lighting, most of the companies knew of it, their agents went in flocks, and one of them sold the whole plant outright. The whole business was done by one company, and of course they had their own size and pattern, and engines and dynamos. It was quite a common form of expression there, to "put in a plant." A short time ago, there was a little discussion about importing English submarine cables for the American Government, and one of the manufacturers said that if there were any demand for such cables, he would "put in a plant" and build them. There was a great deal of sensational writing in American papers, and he thought Prof. Thompson must have got rather an exaggerated notion about the frequency of fires due to electricity. Almost every fire there was put down to electricity, if there was a wire within 100 yards of the place, but, as a general rule it turned out that electricity had nothing to do with the matter. A great deal of the wiring was laid in what were called interior conduits, pipes of specially prepared uninflammable material, which were put in first, and regular race-ways made, through which the wires were drawn in; very little wood-casing was used. With regard to submarine cables, he thought it would be a long time before iron armouring was given up, and long cables were laid of the ideal type referred to in the paper. Telephony would probably be talked about a great deal at the Congress, but with regard to using the wires to their utmost capacity, and increasing the number of messages sent by a hectoplex circuit, he thought that they wanted to work something in the other direction, and get wires which would carry only one message at a time. At present, there was a good deal of trouble in many places with "hectoplex" telephony, and a simplex kind would be far preferable.

Professor AYRTON asked how Mr. Siemens managed with the Fire Insurance Company in the case he had referred to, where the wires were uncased.

Mr. SIEMENS said the office was politely informed that if they did not like it the policy would be taken elsewhere. He should like to add, with regard to submarine cables, that experiments with such cables were extremely costly, and involved a great deal of time, trouble, and knowledge; you could not jump at conclusions, and had to make a vast number of experiments to find out what was essential and what was accidental. It was not likely that results attained with such difficulty would be published in a hurry without a very strong inducement.

The CHAIRMAN said the paper was most suggestive, and the question of units had been purposely omitted at the request of the Royal Commission. The result proved the wisdom of that course, for if those questions had been taken up, they would have occupied the whole evening, and it would have prevented the possibility of bringing forward many valuable suggestions, which, if they did not bear fruit immediately, would assuredly do so in due time. No doubt there were many electrical questions looming in the air, and that many inventions were simmering, if they had not actually matured, in the minds of many on this side of the Atlantic, as well as on the other. Some, perhaps, were keeping them back for the Congress, and next year he hoped they would hear something of what had been accomplished, instead of mere forecasts of what might be expected. There was a vast diversity of practice between England and America in the matter of electric lighting, principally due to the fact that there the contractor had a free hand, and could do what he liked, and could spend his clients' money, and had no difficulty in getting it. Here he was checked and controlled by the consulting engineer, and also by those who held the purse-strings, by the corporations, private companies, and the Government. An enormous amount of money had been wasted in England, but it was a mere nothing compared to that wasted in the States, though, at the same time, there was no doubt they had gone ahead there in the most remarkable way. The great difference in practice was between belt driving and direct driving. What Mr. Bailey had said about the excellence of the American belts was quite correct, though why it should be so he did not know. At the moment, he was engaged on a careful inquiry into this matter, and he hoped to lay the results before the Congress in Chicago, if there were time; but, he feared, there would be such a plethora of papers that his communication on belt driving would have to be deferred. But the great feature in English engineering, on which the direct driving system had been developed, was the Willans's engine, than which there was no more beautiful machine anywhere. There was at first a great prejudice against it, through the failure of early types, but the recent engines were almost perfection. During the last few days he had had to give a good deal of attention to this matter, a corporation in the North of England having before them the question whether they should adopt horizontal slow-speed engines, or the central valve high-speed direct-acting engine of Willans, and the question turned on the relative cost of maintenance. He had been surprised, on getting accurate returns for 1891 and 1892 of the cost of repairs in different central stations and of engines under his own charge, to find that the cost of the high-speed engines came out lower than that of the low-speed horizontal engines; in fact, it did not exceed two per cent per annum. The wood-casing of wires in houses was due to the in-

spectors of fire-offices; but if anybody could show how houses could be wired without the use of wood-casing, he would be a benefactor to mankind. He had been experimenting in this direction. One whole floor in the General Post Office was now being wired with concentric wires, and without wood-casing, which had in his own experience, in many instances, resulted in fires. Professor Thompson had enumerated the qualities which a satisfactory casing ought to possess; but after all the main question was the cost, and it was this which prevented the spread of electric lighting. The cost of wiring was at present excessive; in London the average cost per lamp was £2 or £2 6s., and he should not be satisfied until it was reduced to 20s. When that point was attained, they would not be met with the objection that it was too costly. A yearly tenant would not go to the expense of wiring, and a landlord who had his house occupied would not do so, and the result was that in houses occupied by yearly tenants the electric light was not introduced. When wiring could be done more cheaply, electric lighting would develop very rapidly, it having been now proved that electric energy could be supplied more cheaply than gas. Prof. Thompson had referred to the South London electricity, but did not refer to the overhead railway in Liverpool, which was the finest example of electricity applied to railway work in the world. It was about eight miles long, was worked with great success, was crowded with traffic, and was a solid sound piece of engineering work. He had also referred to mining, to telotelegraphy, and to magnetic clutches; the latter appliance was one on which the late Mr. Willans was engaged during the latter part of his life, and one of them was in use at Mount Pleasant, but up to the present had not been a great success. With regard to telegraphy, he was inclined to join issue with Prof. Thompson, who spoke of the development of automatic telegraphy in England, but forgot that it was being developed nearly as fast in the United States. It had been developed there by the importation of British industry and British telegraphists. The Western Union Company were rapidly developing a magnificent system of automatic telegraphy, making use of all our new ideas, and we were only too proud to help them. The inventor of multiplex telegraphy could not get it applied in the United States; it was shown as a novelty at the Philadelphia Exhibition, nine years ago, but no one in America would take it up, but he told Mr. Delaney that if he brought it to England they would try it, and if successful it should be adopted. He did so, and it was now in use all over the country, but was not yet employed in America. He did not despair of speaking across the Atlantic by telephone; he knew that it could be done theoretically, and whether it were done practically was purely a question of £ s. d. Long distance speaking was being developed pretty largely in England; they knew rather more about the constants than contractors did, and by the success of their efforts they had succeeded in obtaining from the British Treasury, about the most difficult body in the world to get money from, £500,000 to develop long distance telephony. He did not think any private company in the world could have done as much. They had established telephony between London and Paris, by means of one of the best telephone cables ever laid, which was made by Mr. Siemens, and had laid another cable, made by the same firm, between Scotland and Ireland, which was more successful still. He did not think he should be able to induce the British treasury to spend two millions on laying a cable to America; but with the help of Mr. Siemens, and that of the Governments of Great Britain, Germany, and America, they might some day lay a speaking cable across the Atlantic. He concluded by proposing a hearty vote of thanks to Prof. Thompson.

The vote of thanks having been passed unanimously,

Prof. THOMPSON, in reply, said he thought Mr. Siemens had misunderstood what he said about the advantages of belt when a dynamo short circuited. What he meant to say was, that a belts was a contrivance for saving from destruction a machine which had a badly designed armature. With regard to wood casing, there was a time, perhaps nine years ago, when, in comparison with the ramshackle work then prevalent, it marked a distinct advance, but that epoch was gone by, and he should be surprised if wood casing was not soon forbidden by the insurance companies which now insisted upon it. He was now engaged in wiring a house in which there would be no wood casing, and he would undertake to say that it would be much safer than if there were. With regard to fires in America, he did not speak from exaggerated newspaper reports, but from inside information, when he said that some New York Fire Offices were becoming uneasy. He believed the reason was that when a fire did take place, it was generally in what might be called a big risk, because the small houses, in which fires occurred from the overturning of paraffin lamps, were not lit by electricity. His remark, as to the slow development of automatic telegraphy in America, did not, perhaps, quite convey his meaning; he should have said, that the use of this device there was belated; he did not doubt the fact, that rapid advances were now being made, but it was only quite recently. With regard to submarine cables, he thought Mr. Webb had slightly misunderstood him. He certainly did not anticipate—at any rate, within a short period—that deep-sea cables would be laid without armouring of some kind, but he thought the present type of Atlantic cable, with a single conductor down the middle, and armoured outside with iron,

would be no longer used. An armour of iron round one conductor, and using something else outside that—the sea or the earth, or another cable—as the return, meant putting in iron between the outgoing and incoming circuit; and that was totally different electrically from a circuit in which the outgoing current and the return had no iron between them. In the telephone cable to Paris, the iron armouring outside had practically nothing to do with the circuit. He believed that, if Mr. Preece's suggestion of a cable, made by Messrs. Siemens, and laid at the joint expense of the American and European Governments, were carried out, it would be one having more than one conductor down the inside, whether it had an iron armouring outside or not. Mr. Siemens said the data with reference to the performance of cables could only be obtained after expensive experiments, and that when such results were obtained, they were not likely to be published in a hurry; but surely, if such experiments were so costly, that was the very reason why, when they were made at the public expense, the results should be published. It was just these facts which scientific men wanted to get hold of, and he should look forward to obtaining some of them at Chicago. It had been the good fortune of that Society, on almost every occasion when an exhibition had been held during the last 20 years, to hear an account of it, when it was over, from Mr. Preece; and he thought the members would not be satisfied next year if they did not hear from him a paper on the Chicago Exhibition, which would be the natural sequence to his previous communications.

Miscellaneous.

CHICAGO EXHIBITION.

The Opening Ceremony.

The President of the United States opened the Chicago Exhibition on Monday, the 1st inst. The proceedings took place in the Administration Building, and are thus described:—

"From the centre platform a special stand was projected, on which the President and Vice-President, the Duke of Veragua, and the higher officials of the Exhibition were accommodated. The foreign diplomatic representatives were seated immediately behind, together with the Senators and members of the House of Representatives, the State Governors, and various other distinguished guests, both ladies and gentlemen.

"As the company took their places a band of 600 performers, under the direction of Mr. Theodore Thomas, played the Columbian March and Hymn. Mr. Milburn, Chaplain to the Senate, then offered prayer, after which Miss Jessie Couthioul read a poem based upon the incidents of Columbus's voyage and called 'The Prophecy,' written by Mr. Croffut, a journalist. This having been received with much applause, the band played the overture to "Rienzi." Mr. George R. Davis, Director-General of the Exposition, next delivered an address, in which he briefly reviewed the efforts made to complete the work of the Exhibition. In this connection, he informed his hearers that the grounds covered 700 acres, on which over 400 structures had been erected, with an aggregate capacity of accommodating upwards of 60,000 persons. All the great nations of Europe and their dependencies had sent exhibits, and the States of Asia and Africa and the Republics of the Western hemisphere were, with few exceptions, all represented. The total expenditure on the Exhibition amounted to over $100,000,000. 'To the foreign nations represented,' concluded the Director-General, 'we bow our grateful thanks.'

"President Cleveland then addressed the assembly. As he concluded his speech, he pressed the button which started all the vast machinery in the Exhibition. The button, which was of ivory, was on a gold telegraph key of the Victor type. The key rested on a pedestal upholstered in navy blue and golden yellow plush, in which were woven in silver the dates 1492-1893. As the President touched the button, there arose immediately from all sides a wild outburst of sound, the people and orchestra uniting in the triumphant strains of Handel's 'Hallelujah Chorus,' while the wheels of the great Allis engine in the Machinery Hall began to revolve and the electric fountains in the lagoons to play. Torrents of water gushed from the great M'Monnies fountain, while the artillery thundered salutes, and the chimes in the Factories Hall and German Building rang merry peals. At the same moment the flags in front of the platform parted revealing the gilded models of the Columbian caravels. The flags of all nations were simultaneously unfurled on all the buildings of the Exhibition. The roof of the Factories Building became gorgeous with red gonfalons, while the Agricultural Building was dressed in ensigns of orange and white. In short, it was a magnificent transformation scene, and amid all the cannon continued to boom and the people to cheer, while the band played the National Anthem."

THE PRODUCTS OF PERSIA.

In spite of the total absence of any regular system of irrigation, and the enormous difficulties that farmers in Persia have to contend with in watering the fields by the aid of snow and rain, the country—according to a communication by Ahmed Bey in the *Journal des Economistes*—produces not only enough

cereals to supply the wants for home consumption, but leaves a considerable balance for exportation to Russia, Turkey, and India. Wheat and barley abound throughout the kingdom, but particularly at Azerbaïdjan, Khorassan, Fars, and Kirman, and these were the districts that furnished supplies to the Russian army in the Turkestan war of 1880-81. Rice and millet are largely cultivated in the neighbourhood of Ispahan and in the northern provinces; and, although there is a very large consumption of these articles in the country itself, considerable quantities are exported to Russia. In 1889, the total exports of cereals amounted in value to 1,500,000 francs (£60,000). Sugar-canes, which are grown in the environs of Awas and of the basin of the Karoun have for years enjoyed a high reputation; but European competition in this article is so keen that it is France and Russia which now supply Persia with sugar. A Belgian sugar company has recently been established at Teheran, and there is every reason to believe that, if its affairs are conducted with intelligence, considerable profits will result from the immense quantity of beet which is grown in Khorassan, Ghilan, and Mazinderan. Cotton is grown throughout the country, and the principal centres of its cultivation are Khoï and Ourmia in Azerbaïdjan; there are important cotton factories at Yezd and Kirman which annually consume more than 65,000 *mans*. Immense gardens of mulberries exist in Ghilan, Mazinderan, and Khorassan, and the climatic conditions permit the cultivation of silk on a colossal scale. At the present time Yezd, Kashan, and Ispahan have important silk factories, consuming annually more than 15,000 *mans*. The general production is estimated at 422,500 *mans* in 1889, and in the same year more than 140,000 *mans* were exported, chiefly to Turkey, Bombay, and Marseilles. Persia produces two descriptions of tobacco: in the south, especially in the environs of Shiraz, a particular kind is grown for the *narghileh;* the northern provinces produce a tobacco known as tombac, and another description resembling Turkish. Considerable quantities of Turkish tobacco are exported to Turkey, Arabia, Egypt, Russia, and India. Persian opium is celebrated throughout the world, and the principal centres of its production are the provinces of the south — Khorassan, Hamadan, Azerbaïdjan, and Kurdistan. In 1889, the exports of this article amounted to 8,000 cases, of a value of about £840,000, and the countries of its destination were China, Java, Egypt, Arabia, America, and the United Kingdom. Persia produces large quantities of gum, which are exported almost entirely to Russia and the United Kingdom. Certain provinces produce indigo in sufficient quantities both for home consumption and for exportation. Except France, there is hardly any country that can compare with Persia in the abundance, variety, and delicacy of her fruits. She produces olives, grapes, dates, peaches, apricots, plums, melons, pumpkins, nuts, &c. The olive abounds throughout the whole of Northern Persia. Up to 1889 its cultivation was restricted to home requirements, but since that date the Shah has conceded the cultivation of this fruit to a Russian contractor, who has introduced perfected systems of cultivation. Dried fruits, such as *Kishmish*, or dried red grapes, and *Tabarza*, dried white grapes, occupy a prominent place among Persian exports. As regards Persian wines, these have been celebrated since the time of Herodotus. At the present day the centres of the wine production are Shiraz, Kirman, Yezd, Khorassan, Ispahan, Hamadan, &c. The wines of Shiraz resemble Burgundy. Ahmed Bey says that in course of time the viticultural industry is expected to become one of the most important in the whole of Persia. Another source of national wealth consists in the supply of sheep, goats, and horses. As regards the former, a particular breed is raised in Khorassan, Ispahan, and Shiraz, the skins of which, after having passed through the tanneries of Hamadan, are sufficient not only for all the hats required by the Persians themselves, but to provide an export amounting in value to £193,000. Horses are exported to the value of £200,000 annually. As regards the mineral wealth of the country, Persia may be divided into five zones. The first, Azerbaïdjan, is particularly rich in iron, lead, copper, saltpetre, and coal; in the second, which extends from Rudbar to Asterabad, the district abounds with iron, lead, copper, and coal. The third zone comprises Khorassan, of which the mines near Nishapour are rich in turquoises, and in the other parts of the province in copper, lead, coal, salt, and silver. The fourth zone includes Kirman, Ispahan, and Shiraz, and contains, in addition to copper, lead, and silver, manganese, marble, mercury, antimony, cobalt, nickel, and sulphur. The fifth zone, comprising the littoral of the Persian Gulf, is particularly rich in petroleum and lithium. The Persians have from time immemorial excelled in the arts and industries, and at the present time, in spite of the competition of Europe and the general decadence of the country, Persian products bear the stamp of their native superiority, and they take the first rank, as regards originality of design and manufacture, among the people of Western Asia. Of all the manufactured articles the most remarkable are carpets, which are exported to France and England, and amount in value to between £40,000 and £50,000 annually. After carpets come felts and shawls, which are manufactured in Khorassan, Kirman, and Ispahan, the factories of which compete very successfully with those of Cashmere; tissues of cotton, such as *Kalamkar*, *Kashan*, and *Kerbar*, and silk and velvet tissues, which are maufactured in Ispahan, Kaduk, and Resht. As regards Persian embroideries, which were so celebrated at the commencement of the century when they were without a rival in the markets of Western Asia, these are now almost entirely replaced by the products of Marseilles and

Manchester. The decadence of the ceramic art is extreme, and Ahmed Bey says it would be difficult to find throughout the whole of Persia a workman who would be able to imitate the old works in faïence metal or clay, of which time is incapable of effacing the lustre, and which ornament the museums of Europe. It is only in certain towns, such as Shiraz, Behbeham, and Ispahan, that they appear to have preserved some vague recollections of the art of working in enamel, but nothing beyond this appears to have been retained of their old skill in this branch of industrial enterprise.

General Notes.

The Population of British Guiana. — According to the last census of British Guiana, the inhabitants of that colony number 278,328, exclusive of 10,000 aborigines scattered within the woods and forests, beyond the reach of enumerators. The population is made up as follows:—Europeans, 4,558; Portuguese, 12,166; East Indians, 105,463; Chinese, 3,714; Africans, 3,433; blacks, 112,155; aborigines, 7,463; mixed races, 29,029; races not stated, 347. The East Indians are employed as coolies on the sugar estates, and are very prosperous.

Strangeways Arts and Crafts Exhibition. —An Arts and Crafts Exhibition was opened at the Refuges, Strangeways, Manchester, on Tuesday, May 2. The Mayor of Manchester presided, and said it was a great pleasure to him to take part in any undertaking connected with this noble institution. The education of the children brought up under its roof was not confined to books. They were also taught useful handicrafts, so that when the time came for them to leave the institution, they were in a position to begin useful work, and earn their own livelihood. Mr. W. J. Crossley, in declaring the Exhibition open, said its object was to encourage arts and handicrafts in institutions such as the Refuges, the Lads' Clubs, and others with like aims. The work of about twenty institutions was represented in the Exhibition, and was contributed by girls as well as boys. Very little attention was given by parents of the working-classes to the tastes and talents of their boys in choosing an occupation for them. In most cases the occupation a boy was to follow was determined by the particular place where he happened to be able to find employment. One of the advantages of these institutions was that it gave boys an opportunity of showing what was in them, and, perhaps, of getting into a sphere of life more suitable for them. Mr. T. C. Horsfall, in moving a vote of thanks to the Chairman, expressed the hope that the Town Council would make an effort to open in Manchester, at no distant date, a collection of good products of the industrial arts, supplemented with copies of things too valuable to obtain. Such an exhibition would be more valuable, from some points of view, than a collection of work purely of the fine arts.

Gold Mining in British Guiana. — The Colonial report on British Guiana just issued gives the result of the working at the gold-fields in that colony. Up to the date of the report placer mining had been the only work, and this month by month was drawing increased expeditions to the fields. Ten years previously the output of gold amounted to £187; in the following year the return was *nil*. In 1885 washings produced £3,249; in 1886, when the gold industry really commenced, the return was £23,342; in 1887, £44,427; in 1888, £55,566; in 1889, £109,234; in 1890, £234,324, and in 1891, £375,289. The Government Secretary relates the following incident:—"A year or two ago," he writes, "a proprietor returned to town from the gold-fields having, as he stated, found a paying place. Not being in possession of sufficient ready-money to work his find he borrowed, or rather had advanced to him by two gentlemen in town, the sum of £50, on the understanding that they were each to receive a third share in the undertaking. Thus set up the prospector returned to his placer, working, to commence with, only a 'tom;' before long gold by the cwt. was the yield, and to-day the fortunate trio each enjoy an income of not less than £10,000 a year. This is not the only rich find, some of the other placers giving a return of 1,000 ozs. a month." It is added that quartz mining would in all probability be started on an extensive scale. Specimens of quartz of a friable nature, picked up on placer claims in the north-western district had been tested and found to give a result of 56 ozs. to the ton, whilst from another district a sample between 500 pounds and 600 pounds weight gave a return of 152 ozs. of gold to the ton. There were about 7,000 labourers employed in the gold-fields, with an average wage of 2s. 8d. a man per working day.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at Eight o'clock:—

May 10.—J. B. Hilditch, "The Richmond Lock and Tidal Weir."

May 17.—F. E. Ives, "Composite Heliochromy."

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

May 18.—Sir Raymond West, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results." The Right Hon. Sir James Fergusson, Bart., G.C.S.I., K.C.M.G., C.I.E., M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock:—

MAY 16.—W. B. PERCEVAL, Agent-General for New Zealand, "Aspects of Federation."

APPLIED ART SECTION.

Tuesday evenings, at Eight o'clock:—

MAY 9. — PROF. W. M. FLINDERS PETRIE, "Primitive Art in Egypt." EDWARD J. POYNTER, R.A., will preside.

MAY 30.—JAMES DALLAS, "Devonshire Pottery." C. M. KENNEDY, C.B., will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock:—

C. HARRISON TOWNSEND, F.R.I.B.A., "Mosaic: its History and Practice." Two Lectures.

LECTURE I.—MAY 8.—Craft principles—Illustrations from glass-painting—Special need in mosaic of study of old examples—Definition of mosaic—Florentine, Sectile, Alexandrinum, &c. — Roman work—Early Christian examples—The art traced from the 5th to the 15th centuries by examples (illustrated by lantern) at Rome, Ravenna, Constantinople, Torcello, Monreale, Florence, &c.—Commencement of decadence in 15th century—Its causes and course.

LECTURE II.—MAY 15.—Revived interest in mosaic — Its method and materials — *Smalts*, or enamel—Its composition—Gold and silver *Tesseræ*—Their application—Cements—Lime and oil, various formulæ – Methods of work *in situ* and in the studio —Principles and lessons learnt from old examples.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 8 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. C. Harrison Townsend, "Mosaic: its History and Practice." (Lecture I.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. R. F. Grantham's Paper, "Recent Experience in Sewage Filtration considered in Relation to River Pollution."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. W. M. Conway, "Exploration and Climbing in the Kara-koram Mountains."

TUESDAY, MAY 9 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Prof. W. M. Flinders Petrie, "Primitive Art in Egypt."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. R. K. Douglas, "Modern Society in China."

Medical and Chirurgical, 20, Hanover-square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Messrs. M. B. Jamieson and John Howell's paper, "Mining and Ore-Treatment at Broken-hill, New South Wales."

Asiatic, 22, Albemarle-street, W. 4 p.m.

North-East Coast Institute of Engineers and Shipbuilders, Durham College of Science, Newcastle-on-Tyne, 8. p.m. 1. Discussion on Messrs. Jordan and Marlborough's paper "Types and Proportions of Mercantile Steamers." 2. Discussion on Mr. S. O. Kendall's paper "Strains of Tank Steamers."

Photographic, 50, Great Russell-street, W.C., 8 p.m.

Anthropological, 3, Hanover-square, W., 8.30 p.m. 1. Mr. C. Dudley Cooper, "Notes on the Skull of an Aboriginal Australian." 2. Mr. C. Hose, "Borneo." 3. Mr. R. G. Leefe, "The Natives of Tonga."

Colonial Institute, Whitehall-rooms, Hotel Métropole, Whitehall-place, S.W., 8 p.m. Mr. H. Boyd-Carpenter, "The Influence of Commerce on the Development of the Colonial Empire."

WEDNESDAY, MAY 10...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. B. Hilditch, "The Richmond Lock and Tidal Weir."

Geological, Burlington House, W., 8 p.m. 1. Prof. J. F. Blake, "The Felsites and Conglomerates between Bethesda and Llanllyfni, North Wales." 2. Messrs. Philip Lake and Theodore T. Groom, "The Llandovery and Associated Rocks of the Neighbourhood of Corwen."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting). Mr. J. Wilson Steven, "The Introduction of Rubble Blocks into Concrete Structures."

United Service Institute, Whitehall-yard, S.W., 3 p.m. Colonel G. V. Fosberry, "The Phonograph, and its Applications to Military Purposes."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

Entomological, 11, Chandos-street, W., 7 p.m. 1. Professor L. C. Miall, "*Dicranota*, a Carnivorous Tipulid Larva." 2. Dr. T. Algernon Chapman, "A Lepidopterous Pupa (*Micropteryx purpurella*), with functionally active Mandibles."

THURSDAY, MAY 11...Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. John Leighton, "Pictorial Advertising—its Use and Abuse Demonstrated."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Atmosphere."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Mr. W. B. Sayers, "The Prevention of Sparking; Compound Dynamos without Series Coils or Magnets; and Self-Exciting Dynamos and Motors Without Winding upon Field Magnets."

Mathematical, 22, Albemarle-street, W., 8 p.m.

FRIDAY, MAY 12...United Service Institute, Whitehall-yard, 3 p.m. Mr. C. A. Hereshoff Bartlett, "The Banqueting House, Whitehall."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Lord Kelvin, "Isoperimetrical Problems."

Astronomical, Burlington-house, W., 8 p.m.

Clinical, 20, Hanover-square, W., 8½ p.m.

Physical Science Schools, South Kensington, S.W., 5 p.m. 1. Mr. C. V. Boys, "The Drawing of Curves from their Curvature." 2. Prof. Oliver Lodge, "The Foundations of Dynamics."

SATURDAY, MAY 13...Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. Henry Craik, "Johnson and Swift."

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FRIDAY, MAY 12, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the Imperial Institute, South Kensington (by permission of the Executive Council), on Wednesday evening, June 21.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member.

Further particulars as to the arrangements will be announced in future numbers of the *Journal.*

CANTOR LECTURES.

On Monday evening, May 8, C. Harrison Townsend, F.R.I.B.A., delivered the first of two lectures on "Mosaic: its History and Practice."

A series of drawings, from the South Kensington Museum, was kindly lent for the occasion by the Science and Art Department.

The lectures will be printed in the *Journal* during the summer recess.

APPLIED ART SECTION.

Professor W. M. Flinders Petrie read a paper on Tuesday evening, May 9, on "Primitive Art in Egypt." Edward J. Poynter, R.A., presided.

The paper and discussion will be printed in a subsequent number of the *Journal.*

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Tuesday, April 9. Present: Sir Frederick Bramwell, Bart., D.C.L., F.R.S., in the chair; William Anderson, D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Braddon, K.C.M.G., Michael Carteighe, R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, B. Francis Cobb, Prof. James Dewar, M.A., LL.D., F.R.S., Sir Henry Doulton, Francis Elgar, LL.D., Prof. Clement Le Neve Foster, D.Sc., F.R.S., Sir Douglas Galton, K.C.B., D.C.L., F.R.S., Charles Malcolm Kennedy, C.B., John Biddulph Martin, John Fletcher Moulton, Q.C., F.R.S., John O'Connor, Wyndham S. Portal, and Professor William Chandler Roberts-Austen, C.B., F.R.S.

RECEPTION OF DELEGATES BY THE NEW YORK CHAMBER OF COMMERCE.

The Foreign Office has submitted to the Royal Commission copies of a circular, from the United States Secretary of State, relative to the reception of delegates to the Exhibition by the New York Chamber of Commerce. Writing to the American Secretary of State, Mr. Henry Villard, Chairman of the Chamber, announces that a special committee has been appointed "for the reception and care of foreign visitors who will attend the World's Fair at Chicago as representatives of State and municipal Governments, and of commercial and industrial bodies, and of individuals of distinction in the learned professions, in science, and the arts. The committee will be glad to welcome all such at their rooms at the Hotel 'Waldorf,' Fifth-avenue and Thirty-third-street in the city of New York, and to serve them in every possible way." He adds:—"The committee would esteem it a great favour to be informed in advance by the foreign Governments, through the Department of State at Washington, of the names, character, and the time of arrival in this country of the official guests to be expected." The committee is composed of the following gentlemen:—Henry Villard, Seth Low, Morris K. Jessup, John D. Rockefeller, Charles S. Fairchild, Horace Porter, Abram S. Hewitt, Cornelius N. Bliss, Oscar S. Straus, J. Seaver Page, Vernon H. Brown, Woodbury Langdon, Whitelaw Reid, John Bigelow, William E. Dodge, William Steinway, J. Edward Simmons, John Claflin, James W. Tappin, Carl Schurz,

Charles S. Smith, Chauncey M. Depew, John S Kennedy, J. Pierpont Morgan, Andrew Carnegie, Samuel D. Babcock, Geo. Rutledge Gibson, John Austin Stevens, Louis Windmuller, and Levi P. Morton.

Proceedings of the Society.

TWENTIETH ORDINARY MEETING.

Wednesday, May 10, 1893; CHARLES BURT, J.P., Mayor of Richmond, in the chair.

The following candidates were proposed for election as members of the Society:—

Keen, John, 151, Johnson-street, Victoria, British Columbia.
Neild, Frederick, 37, Tavistock-square, W.C.
Rhodes, Caleb, 4, Grosvenor-terrace, Beverley-road, Hull.
Slingo, William, 65, Chelsham-road, Clapham, S.W.
Yeatman, F. F., Electric Light Depôt, Reading, Berks.

The following candidates were balloted for and duly elected members of the Society:—

Capper, Prof. David Sing, M.A., King's College, Strand, W.C.
Fletcher, George, 59, Wilson-street, Derby.
Hatton, John Leigh Smeathman, M.A., People's Palace, Mile-end, E.
Ryder, Charles Foster, B.A., Gledhow-hill, Leeds.

The paper read was—

THE RICHMOND LOCK AND TIDAL-WEIR.

BY J. B. HILDITCH.

When I was asked to read a paper on the Richmond Foot-bridge and Lock, before this Society, I first thought that it would be better postponed until the work was complete, and its practical usefulness demonstrated, rather than that results should be anticipated.

However, we now have one arch practically finished, and fitted with its sluice, which can be raised and lowered into the river when desired.

The single arch is in a condition to be described as in working order, although it cannot be brought into use for holding up the water until the lock and the whole of the structure is completed and ready for opening.

The interest manifested in this scheme has been remarkable from its inception, and no doubt results, in the first place, from the great regard that Englishmen have for their favourite river. Also from the fact that at last something is being done to restore the water to its former level in the neighbourhood of Richmond, after the long and weary controversy as to the proper course to be pursued in the treatment of a river like the Thames, and this under most difficult circumstances of situation, which appeared to render it almost impossible to provide for the interests of the navigation, and at the same time the welfare of the towns upon its banks. And, lastly, I think, from the novelty of the scheme itself, which at once attracted the notice of engineers, and has more recently awakened the attention of the general public. This has been noticed in a marked degree since the erection of the foot-bridge has progressed, and a period for opening in the not far distant future could be looked forward to.

On account of the incompleteness of the work, I have thought it would be better on the present occasion to treat the subject in an explanatory manner, and not weary you with technical details. I, therefore, propose to review the altered condition of the river below Teddington Lock since the removal of old London-bridge, in 1833, and the resulting difficulties in the upper tidal portion of the river, which ultimately led up to the initiation of the scheme we have to consider.

After investigating the cause, and illustrating—by the aid of photography and the lantern—the condition of the river, I will describe the work itself, and the purpose it is designed to effect.

Although we cannot do otherwise than regard the removal of old London-bridge in the light of an improvement to the general navigation, there can be no doubt that it was the great factor in causing the loss of water, and subsequent deterioration, in recent years, of the beauty of the upper tidal portion of the river.

My subject being so intimately connected with the tides, it will be necessary to glance at the tidal action of the Thames, which, although a mere rivulet, when compared with the gigantic rivers abroad, is remarkable for many valuable characteristics, which entitle it to be considered one of the most important streams in the world.

I do not know if it may have ever occurred to you why the great city of London, with its enormous commerce and wealth, is situated

where it is, but the answer, I think, is plain—that it owes its origin and growth to the magnificent waterway of the Thames. And I will go further, and say that England, as a country, would occupy a far less important position in the world if the Thames had never existed.

It seems as if such a metropolis as London should form the centre of a vast continent, instead of which we find it situated almost in the corner of a comparatively small island. This vast aggregate of population has gradually developed and clustered round a spot where nature provided unusual facilities for communication with the other countries of the globe.

When we look at a map, we find London situated near the top of the tideway of the Thames, at a point where the river narrows sufficiently for it to have been practicable in the early days of engineering to build a bridge which permitted of easy intercourse between the otherwise separated counties of Surrey and Middlesex, whilst at the same time depth of water was found for comparatively large vessels to anchor.

A river has often been said to be one of God's best gifts to man, and a vast dowry was bestowed here, which, if it had been realised in its completeness when London was in its infancy, might have been better turned to account.

The Thames, as a river, may be said to possess many virtues and no vice. Unlike so many rivers at home and abroad, it has neither bar nor bore, whilst its stream and tidal energy are sufficient at all times to convey the traffic on its waters, and keep the passages to the sea free from silting. Its water, in a natural and unpolluted condition, would be clear as crystal, and its gentle flowing stream and tides are in every respect well adapted for commerce. Denham has described it in the well-known lines—

> "Though deep, yet clear, though gentle, yet not dull,
> Strong without rage, without o'erflowing full."

Such a river deserved better treatment than to be robbed of its upland water for the use and cleansing of a big city like London, and to have its tidal basin used as a receptacle for sewage.

It is only by comparison with other rivers that the features to which I have called attention can be adequately realised, and we have not to travel far to find a river of about the same dimensions possessing characteristics of an opposite kind. Buckland has described how on the Severn the first wave of the rising tide comes in with a rush that, when the stream is at its lowest ebb, broadens the great river from a narrow span of 50 yards to a breadth of nearly a mile in a few minutes. Instead of the gentle turning of the stream, which we call flood, the rising water of the Severn sometimes rushes with a noise and announces its arrival at the first lock by sending the gates flying open. It shortly tops the weir at Gloucester, and then goes on thirteen miles up the river to Tewkesbury, and, passing over the weir there, even reaches as far as Worcester. At Chepstow, near where the Wye falls into the mouth of the Severn, the tides sometimes rise 50 feet.

In consequence of these disadvantages, the Severn is almost unnavigable below the first lock, and the traffic to the sea has to pass through a long canal to Sharpness Point. Similar waves, but of less strength, come up the Mersey and the Humber, and no doubt Sir Walter Scott describes in "Marmion" what he had often seen, in the words—

> "Love swells like the Solway, but ebbs like its tide."

On the Seine and the Rhône there are strong tidal-waves, but it is on the Amazon that the phenomenon attains its greatest magnitude, the very name of the river being derived from an Indian word signifying boat-destroyer, in allusion to the fury of its sudden tides. It may be a magnificent river to contemplate on a map, but, with such terrors as these, very difficult for man to turn to account for the purposes of navigation.

These tides occur at the periods of new and full moon, when the influence of the sun is added to the attraction exerted by the moon, producing full or spring-tides, whereas, at the periods between, the influence is antagonistic, and there is less tendency for the water to heap up, and we have what are called neap-tides.

The strength and direction of the wind affect very much the height of the tides, and, in a less degree, the barometrical pressure of the air. There are also the currents of the ocean, but the most energetic causes of complexity in the tides are the inequalities that mark the bed of the sea, and its geographical distribution in contact with immense masses of dry land in its basin. In the open ocean the rise and fall of the tide often do not exceed one to two feet, but where currents are strong and obstructions met with, the water heaps up more or less according to the con-

figuration of the coast line. It would be impossible for the moon and the sun to raise the water of the free ocean more than eight feet, whereas in the Bay of Fundy, Nova Scotia, it sometimes rises 70 feet.

Now, the great advantage that the Thames possesses in regard to the tide is owing to the mouth of its estuary being opposed to, instead of—like the Severn—being in the direction of, the advancing tidal-waves from the Atlantic. In consequence of its being snugly tucked round the corner, it enjoys the advantage of a double tide. One tidal-wave enters direct up the English Channel, whilst another comes from the North Sea, and these do not synchronise. The first is naturally the highest of the two; the latter the largest in volume and of longer duration, but, being subject to the influence of the wind, they vary accordingly.

When the tide-wave from the Atlantic arrives at the British Isles, it is interrupted in its progress, and divides into three branches. One branch flows eastwards up the English Channel, and quickly fills the mouth of the Thames. A second branch advances through St. George's Channel into the Irish Sea; while the third and principal branch of the same wave proceeds along the west coast of Ireland and Scotland, rounds the northern extremity of the latter, and flows slowly down the North Sea to the mouth of the Thames, after taking about twenty hours to compass the distance. The consequence is that under ordinary circumstances the elevation due to the English Channel wave takes place some two hours or more after a North Sea wave has spent itself, and prolongs, by its directly applied energy, the period of high water.

But it sometimes happens that the English Channel-wave is accelerated and increased by a south-west gale, whilst the North Sea wave is retarded, and the two waves arrive with combined force about the same time. The effect of the barometer falling is to take so much weight from the surface of the Thames, and as the tidal energy has, like all other forces, to expand itself, it has so much less work to do in heaping up the water. Occasionally, all these combinations happen at once, when, perhaps, there is a good deal of land-water in the river, and these forces meeting together, in the confined space of the mouth of the river, will produce a very high tide right up to Teddington.

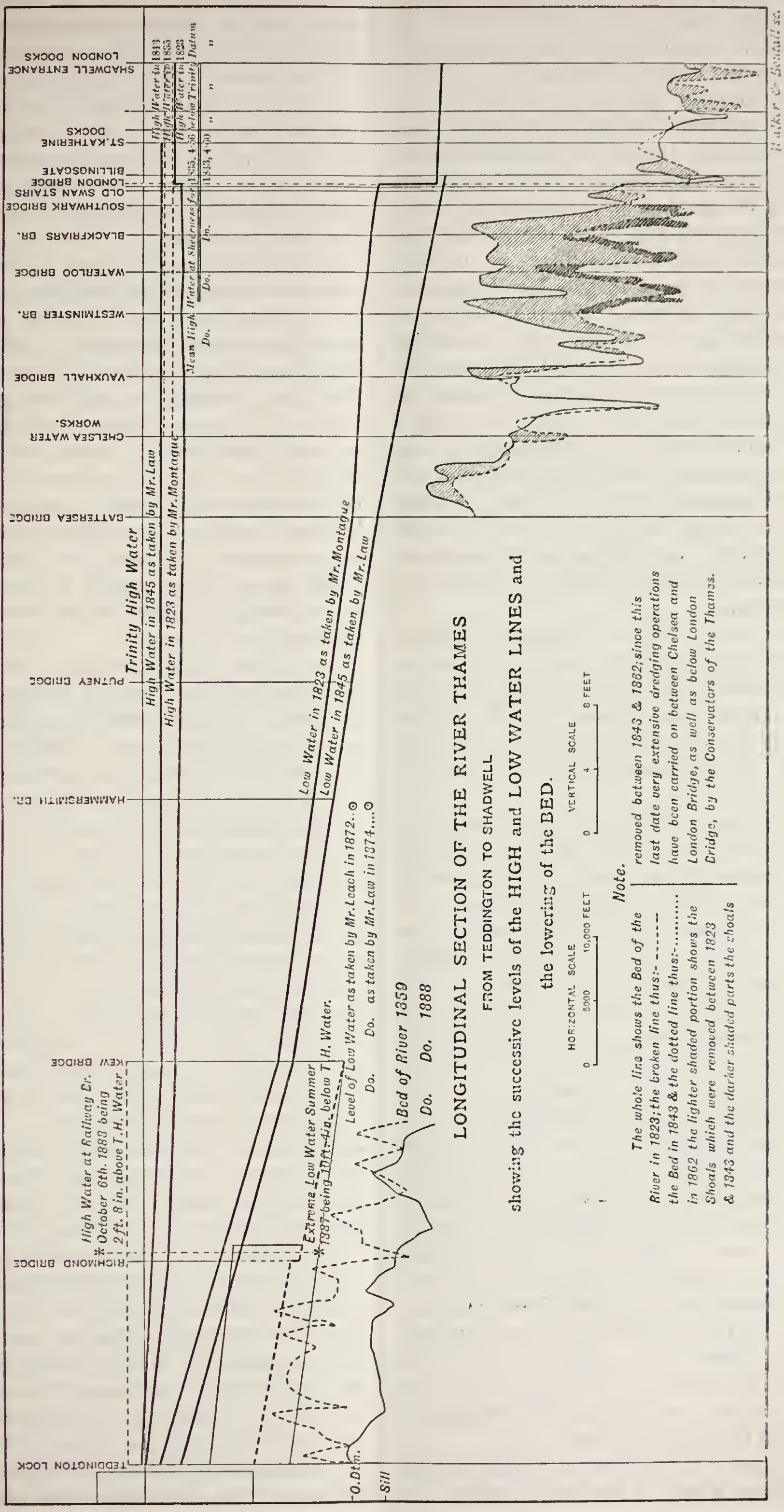
In the improvement of rivers, it has always been considered desirable to encourage the tidal-flow as far as possible, and let it gradually die into the stream; but in the case of the Thames above London we have to deal with a river that has been artificially treated for hundreds of years. Old London-bridge was, to all intents and purposes, a weir of formidable dimensions, and if the theories of some engineers were entirely correct, its objectionable nature ought to have ruined the river centuries ago. The fall through its arches must have been a great inconvenience without any lock, but besides preserving a higher level above, the pounding up of the water was utilised to work water-wheels to supply London with water, and on this account was submitted to. The water-wheels were removed in 1822, and the old bridge itself, a little more than ten years afterwards. Owing to the continuous opening out and deepening of the bed of the river since, we have gradually become more exposed to tidal influence above, at the same time that we have lost much of the natural stream by the abstraction of water by our modern water companies.

The old impediments in the river formerly delayed the ebb until it was again overtaken by the tide, and, on the other hand, in consequence of the tide being partially obstructed, it never rose above them to its full height, whilst the period of high-water was prolonged. The removal of the bridges, and subsequent lowering of the bed of the river by dredging operations, has not only increased the force of the tides, but facilitated the flow of the returning ebb, leaving larger foreshores exposed for a longer period.

Telford, when reporting to the Corporation of London on the 11th June, 1823, stated that "The removal of London-bridge will admit a greater body of water to flow up the river to the westward, and with a greater velocity, which together will considerably increase the momentum, and it is equally certain that the same cause will operate in the ebbing-tide, and leave the bed of the river dry for several hours in the latter part of the ebb."

Mr. Henry Law, who has had, I believe, the longest experience of any engineer in connection with the river Thames, and so efficiently gave his professional services in the promotion of the Richmond Foot-bridge and Lock Bill, took a number of observations, showing the loss of water in the tidal Thames, and the diagram will enable me to demonstrate the alterations of level that have taken place during the period under review.

I will now refer to the longitudinal section of the river from Shadwell to Teddington, in



LONGITUDINAL SECTION OF THE RIVER THAMES
FROM TEDDINGTON TO SHADWELL
showing the successive levels of the HIGH and LOW WATER LINES and
the lowering of the BED.
HORIZONTAL SCALE
0 5000 10,000 FEET
VERTICAL SCALE
0 4 8 FEET
Note.
The whole line shows the Bed of the River in 1823; the broken line thus:- the Bed in 1843 & the dotted line thus:- in 1862 the lighter shaded portion shows the Shoals which were removed between 1823 & 1843 and the darker shaded parts the shoals removed between 1843 & 1862; since this last date very extensive dredging operations have been carried on between Chelsea and London Bridge, as well as below London Bridge, by the Conservators of the Thames.
TEDDINGTON LOCK
RICHMOND BRIDGE
KEW BRIDGE
HAMMERSMITH BR.
PUTNEY BRIDGE
BATTERSEA BRIDGE
CHELSEA WATER WORKS.
VAUXHALL BRIDGE
WESTMINSTER BR.
WATERLOO BRIDGE
BLACKFRIARS BR.
SOUTHWARK BRIDGE
OLD SWAN STAIRS
LONDON BRIDGE
BILLINGSGATE
ST. KATHERINE DOCKS
SHADWELL ENTRANCE LONDON DOCKS
Trinity High Water
High Water in 1845 as taken by Mr. Law
High Water in 1823 as taken by Mr. Montague
Low Water in 1823 as taken by Mr. Montague
Low Water in 1845 as taken by Mr. Law
High Water at Railway Br. October 6th. 1883 being 2 ft. 8 in. above T. H. Water
Extreme Low Water Summer 1887 being 10 ft. 4 in. below T. H. Water.
Level of Low Water as taken by Mr. Leach in 1872
Do. Do. as taken by Mr. Law in 1874
Bed of River 1859
Do. Do. 1888
Mean High Water at Sheerness for 1835, 4.56 below Trinity Datum
Do. 1843, 4.60
Do.
Do.
High Water in 1843
High Water in 1835
High Water in 1823
O.Dtm.
Sill

which the proportion of the horizontal scale to the vertical scale is as 1,250 ft. to 1 ft., the length of the river being very much compressed in order to get it in the diagram.

The undulating lines at the bottom of the diagram represent the bed of the river. The shaded hillocks, the shoals removed between 1823 and 1843; the darkest shaded parts, the lowering of the bed of the river and shoals removed between 1843 and 1863. The diagram first records a complete set of tidal observations taken in 1823 by Mr. Montague, the then City Surveyor, for the purpose of showing the effect produced by the removal of London-bridge, a work that had become necessary. The lowest of the top lines represents the average high-water of that time. It shows a fall of 8 inches through London-bridge, owing to the obstruction it caused, and the resistance of old Westminster-bridge heaped the water slightly up there, and then the height of the water rose until, at Teddington, it was above Trinity high-water mark, which is represented by the top line.

The low-water line rose suddenly at London-bridge to the extent of 5·4 inch, the extent of the fall through the arches; it was then kept up slightly by the resistance of old Blackfriars and Westminster bridges, and then it continued to rise gradually until it reached Teddington.

The next series of observations taken by Mr. Law, in 1845, shows that the range of tides had considerably increased, that high-water had become higher and low-water lower.

After the removal of old London-bridge, the bed of the river became considerably lowered, but the effect of more water passing up and down with the tide was not felt until many years afterwards, on account of the numerous shoals between it and Westminster, when we have evidence that this increased scour caused the foundations of both old Westminster and Blackfriars-bridges to give way. More recently it has occasioned a large sum to be laid out in maintaining Waterloo-bridge, the foundations of which had become imperilled from the increased scour. Since 1862, very extensive dredging has been carried on, both above and below London-bridge, so that further impediments to the flow of the tide have been removed, causing higher tides, whilst, on the other hand, few obstacles now remain to detain the ebb, which runs out very quickly, resulting in a reduced level at low-water.

The range of spring-tides at London-bridge, in 1799, was about 15 feet, or 18 inches less than at Sheerness. Now, the average maximum tides at London-bridge reach 21 feet, being nearly five feet more than at the mouth of the river. The oscillatory motion of the water travels up and down the river similarly to the swing of a pendulum, and although most of the increased range is due to elevation of surface, the water at London-bridge frequently recedes about a foot below the lowest sea-level.

Many people get the idea in their minds, from witnessing the ebb and flow of the river, that the tides are a fixed quantity, which must be accommodated somewhere, otherwise the banks would be overflowed; but it is not so. The tide is simply energy from the mouth of the river, in the form of a wave, which continues to exert itself until it meets with obstacles that deprive it of its momentum. The supply of water from the ocean is inexhaustible, and it must, therefore, be evident that if no water were permitted to pass, say London-bridge, whilst the tide was coming in, the only result would be that so much less water would enter the mouth of the river.

The effect of the increased range of tide upon the neighbourhood of Richmond, it will be noticed, has been most remarkable. Before the removal of old London-bridge, the difference of level between the average high and low water at Richmond was comparatively small—only about 3 ft. 6 in. This afterwards became enormously increased, so that the difference now between the average height of spring-tides and low-water is over ten feet, and is indicated by the upper and lower dotted lines, which also show the fall of water through Richmond-bridge. We have often high tides which rise 2 ft. 8 in. above Trinity high-water mark; and on the 5th July, 1892, the lowest water ever recorded marked 11 feet below Trinity high-water, making an extreme difference in range of 13 ft. 8 in.

The lowest thin line shows the lowering of the low-water level proposed in Messrs. Coode and Calver's report; the thin upper and vertical lines the level of water at low tide that will be restored when the works are in operation.

Memorials were first presented to the Thames Conservators from the inhabitants of the neighbourhood between Teddington and Brentford in 1860, and again in 1865, calling attention to the loss of water in the upper tidal reaches of the river. In June, 1871, a deputation waited upon the Board, and complained of the lowness of the water, and further deterioration in the condition of the river, urging the construction

of a lock and weir in the neighbourhood of Brentford. After several months' consideration, the Conservators returned an answer that "they regarded as a most weighty objection to the scheme that it would exclude a very large quantity of tidal water, which at present exercises a most beneficial effect on the river below, by the scour which it produces." The lowering of the low-water-level, and the increase in the height of the tides, had been gradually producing a changed effect upon the character of the banks of the river, which lost much of their beauty and picturesque effect. The extreme and continual alteration of the water-level ceased to produce the luxuriant growth of wild flowers, and the roots of the water plants no longer served to hold up the banks without camp sheathing or embankment.

Instead of the gentle placid flow of the stream, which the fisherman and the lover of nature used to delight in, a rapid torrent began to take its place, which, at some points in the river, defied the utmost exertions of the expert oarsman. Water-lilies and weeds, which afforded cover for the fish, disappeared, and the scour of the tides brought up all the filth from the sewage out-falls below London, which, deposited on the foreshore, produced huge banks of mud, where formerly it was almost as clean as the sea-beach.

The facts could not be refuted, and, in consequence of further representations, the Conservancy Board instructed the late Sir John Coode and Captain Calver to report to them whether, having regard to all the interests involved, it would be practicable and prudent for the Board to construct a lock near Brentford or Isleworth, and to advise the Board generally.

The result was a voluminous report, dated February 24th, 1873, which, after reciting the facts and statements of the memorialists, admitted that, "There is no doubt whatever that the comparatively pure water which formerly filled the upper reaches of the tidal Thames—say, from Kew to Twickenham—has been replaced by water charged with matter, more or less offensive, brought up by the spring-tides, which, in a state of comparative stillness, has gradually dropped an offensive deposit upon the foreshores, to as far up as Twickenham, where it has remained and contaminated the air, until the land-floods at the fall of the year have cleared it away again."

After dealing at considerable length with the tidal-flow and its acceleration, which was regarded as an improvement to the river generally, it proceeded to argue that the river would silt up, both below and above the weir, that it would cause tidal loss, and injure the channel below it, and that the navigation of the river would be inpeded. It concluded with the recommendation that, instead of the construction of a lock at Sion reach, which the late Mr. Leach, the engineer of the Conservancy, had estimated would cost between £25,000 and £30,000, "That the river bed be improved by dredging between Teddington Lock and Kew Railway-bridge, to such an extent as will suffice to form as uniform a channel as possible, not less in any part than 100 feet wide at the bottom, with side slopes of four to one, the bed, within the limits named, having an inclination of six inches to the mile."

The estimated cost of the channel described was £34,500, and a plan accompanied the report, showing a further suggested general lowering of the low-water line, which, if carried out, would have involved the destruction of the two middle piers, and three central arches of Richmond-bridge.

A copy of the report was furnished to the memorialists, with which they were very disappointed, but it does not appear that any plan accompanied it, and I do not think they realised at the time that a further lowering of the bed of the river was contemplated, and that Richmond-bridge was in peril. When the agitation for the present lock works were in progress the Conservancy Board kindly allowed us to take a tracing of the plan.

As the Thames Conservancy were not in possession of funds to incur the vast outlay recommended for dredging a channel 100 feet wide, they proceeded to deepen the river in places where it was insufficient for navigation, and form a narrower channel, but as soon as this was dredged, the stream flowed into it, leaving larger foreshores exposed, and the natural dams of the river being partially cut through, the tide ebbed out quicker than before. When the river was deepened in one place, the work seemed to be practically undone by dredging elsewhere.

In the meantime, the memorialists had consulted Mr. Abernethy, who reported to them, on June 5th, 1873, that the best method of procuring an additional depth of water, particularly between Richmond-bridge and Teddington, and preventing the deposition of offensive mud on the shores and in the bed of the river, was by the construction of a lock and weir.

As the depth of water continued to diminish from year to year, so dissatisfaction on the part of the riparian owners and those using the river became more pronounced, and on Oct. 13th, 1883, a public conference of the inhabitants of the neighbourhood took place at the Castle Hotel, Richmond. Several resolutions were passed, and amongst them the following:—"That the various attempts which have been made to improve the state of the river by dredging have not only failed, but made the condition of the river worse than before."

A committee was appointed, with the Earl of Kilmorey as chairman, a subscription list opened, and over £1,000 quickly subscribed towards the expense of promoting a Bill in Parliament.

The result was a report and plan of a proposed weir and locks at Isleworth Ait by Mr. Abernethy, and notice was given by the promoters—through their solicitors, Messrs. Bircham and Co.—of their intention to bring in a Bill in the approaching Session. Mr. Charles Burt, now Mayor of Richmond, and our chairman this evening, made every effort to induce the Thames Conservancy to consider the scheme favourably, and avoid a Parliamentary struggle, but it was to no purpose. They viewed the question chiefly in the light of the maintenance of the navigation, and could only support measures which were for the benefit of the river as a whole. It having been reported to them, by eminent engineers, that the vast interests of the port of London, to which I have alluded in my opening remarks, might be imperilled by the construction of any permanent weir or dam, it followed that the erection of such a work would be resisted.

When they were approached, the answer returned was that they were willing and anxious to ameliorate the condition of things complained of as far as lay in their power, but they could not sanction one portion of the river being restored to the detriment of more important interests, and that the proper course of treatment to pursue in improving the river was by further dredging.

In the end they submitted certain plans, giving four sections of the river at different spots between Teddington and Richmond, and offered, on condition that the notice of the Bill was withdrawn, to spend a large sum of money in improving the river between Isleworth and Teddington Lock, by removing the shoals and mud, securing the banks with stone facings, &c.

A considerable portion of the amount subscribed was consumed in preliminary expenses, and the Committee, having in view the large sum that would necessarily be expended in a Parliamentary contest, had no alternative open to them but to withdraw the Bill, and allow the Conservancy to proceed with their treatment of the river.

Although far from satisfied, some members thought they had succeeded in wresting some valuable concessions from the Board, which, if not all that was desired, at least held out the promise of some reward for their labours.

In this, however, they were greatly disappointed, for matters only continued to get worse. When a further loss of water was first noticed it was attributed to the dry season, and it was said that when a larger instalment of the scheme was carried out, depth of water would be obtained.

However, nothing of the kind took place: boats and barges kept grounding, and within a few weeks of the dredger being set to work between Railshead and Isleworth ferries, the low-water level dropped nearly another foot. A considerable fall of water through the arch of Richmond-bridge now appeared, so that it was most difficult for any but an expert oarsman to row through the arches, and this state of things has continued ever since.

Mr. Abernethy's scheme first set me thinking about a half-tidal lock and weir, and, looking over some old newspaper cuttings, I find I suggested, in a letter to the local paper, in October, 1883, a weir, which, whilst holding up the water, should allow the stream to pass on the level of the bed of the river, and only be operative during the period of low-water, and this is exactly what the Richmond sluices are designed to effect.

In consequence of my having called the attention of the Richmond Vestry to the diminishing level of the water and exposure of the foreshores, as a consequence of attempting to carry out the further dredging of a channel in the bed of a river, which seemed to threaten most serious results to all concerned if further proceeded with, a number of gentlemen, who had supported Mr. Abernethy's scheme, met at my house on July 18th, 1884, to consider what had best be done.

Although these proceedings were complained of, and termed irregular by the Conservancy Board, who continued to prosecute the works they had undertaken, and ultimately spent £23,500 upon them, it really proved the initiative step to a reversal of the policy

pursued so many years, to the detriment of the neighbourhood.

Up to this time a somewhat jealous feeling had existed between the Twickenham Local Board and the Richmond Vestry. Twickenham had on more than one occasion acted independently, but now the extreme sufferings of both called forth a determination to work together. The condition of the river then had become so desperate that the channel between the town and the large ait, known as Eel-pie Island, dried up at low-water. The watermen could not get to their boats, and, to call attention to their miserable plight, took to playing a game of cricket one afternoon in the bed of the river.

The various appeals to the Thames Conservancy were always very courteously but firmly replied to, and held out no hope whatever of the state of things, which became very bad in the summer of 1884, being ameliorated.

About this time a joint committee, consisting of six members of the Twickenham Local Board and six of the Richmond Vestry, was appointed to confer together, and endeavour to bring pressure to bear upon the authorities.

A Royal Commission was suggested; but this, it was found, would be most difficult to obtain for such a small section as three or four miles of the river. An appeal was made to the Board of Trade, and eventually, in 1888, it was arranged that an inquiry should take place before an arbitrator. In order to meet expenses, another appeal was successfully made by Mr. Charles Burt, the chairman of the Richmond Vestry, and Mr. Charles Thrupp, chairman of the Twickenham Local Board, who, together with myself as chairman of the joint committee, composed an executive committee, and the campaign was opened.

Mr. Wolfe Barry, M.Inst.C.E., was appointed, and the evidence was being prepared to lay before him, when the whole scheme collapsed, owing to a stipulation being made that before proceedings were commenced the complainants should deposit £1,500 to guarantee their portion of the cost of the inquiry.

This sum being so much more than was anticipated, and there being no certainty that, if the promoters obtained a decision in their favour, any immediate relief would follow, the idea had to be abandoned, and attention was again given to the promotion of a Bill in Parliament, which, it was thought, even if more costly, would carry with it definite powers to construct works for relief. To proceed on these lines with any chance of success, it was first of all necessary to provide a scheme that would command the confidence and support of able engineers.

All this time I had been studying and making notes of the condition of the river, and I had taken many photographs, showing the extent to which the bed of the river was exposed at low water.

Being convinced in my own mind of the strength of some of the arguments used in opposition to the erection of an ordinary fixed weir of solid construction, I turned my attention to moveable ones, and, in the autumn of 1887, examined several of the Continental systems on the Seine, the Yonne, and the Marne. I returned very much impressed with the magnitude and importance of these works, and feeling that we were very much behindhand in schemes for impounding water at home. At the same time, the conditions and objects aimed at were quite different. Being above tidal influence, they were all designed to maintain a navigable depth of water in dry seasons, and prevent flooding in wet ones, and only required erecting and removing when these changes occurred; whereas, in the case of the Thames at Richmond, a change of level took place with the tide twice in 24 hours.

In most cases the erection of the dams (or barrages, as they are called) is slow and tedious, and their removal almost equally so. To provide for the rise of the tide, it was absolutely necessary to have some scheme that could be completely and readily manipulated in the shortest possible time.

The needle weir and the chanoine wicket, the most largely adopted systems, were exceedingly slow in removal.

The curtain-dam of M. Caméré, at Poses, on the Seine, which is considered a magnificent work of its kind, and was holding up 13 ft. 6 in. of water when I was there, did not possess features that could be readily adopted. The curtains, which somewhat resemble wooden revolving shutters, occupied 15 minutes in rolling up, and the iron frames upon which they worked, suspended from a foot-bridge above, took twenty minutes in raising and ten minutes in lowering.

The hydraulic weir of M. Girard, and the drum weir of M. Defontaine, were the only ones that met the requirement of speedy removal successfully, but they were both expensive systems. I was much struck with the latter, which consists of a succession of balanced paddles, the lower halves being

recessed into the bed of the river. By turning a valve, the head of water maintained causes the paddles to lie flat on the bed of the river, and the weir disappears. When in operation the evenness of the fall of water was very perfect, almost resembling a glass shade, and looking down the river one witnessed the curious effect of two different levels of water, without any apparent cause. The objection to this system was that with tidal action deposit might take place in the drum, and stop its working effectually, and it seemed to me very objectionable to have working parts in the bed of the river, where they were difficult of access.

More than one adaptation of these schemes had to be laid aside with disappointment, and a plan of tidal gates, after occupying much thought and consideration, at length gave place to Mr. Stoney's sluices. The drawings of these interested me very much from the first, but there was no example to be seen in England. It happened that Mr. Stoney had been occupied in obtaining a prolongation of his patent, and a friend of mine, who had advised him, introduced me to him, and also to Messrs. Ransomes and Rapier, of Ipswich, who were interested in working the invention.

About this time the Manchester Ship Canal scheme was making progress, and the conditions met with here more closely resembled those of the Thames at Richmond, on account of the lower portion of the canal being subject to tidal influence. Mr. Stoney's sluices were entertained for regulating the control and discharge of the river Weaver. Mr. Leader Williams and other engineers were about to visit Ireland, where the nearest examples could be seen in operation, and I was invited to join the party. We first visited Ballinasloe, county Galway, and afterwards proceeded to view larger sluices, of 30 feet span, at Belleek, county Sligo. One could not be otherwise than impressed with the facility with which huge gates of this width, 14 feet in depth, and bearing a static pressure of 85 tons—due to the head of water maintained—were readily moved by hand: but, of course, what was visible above the water-line of such a solid erection had not the most pleasing appearance, and was not of a nature that we could propose to introduce into the residential neighbourhood of Richmond.

As a bridge was not required, and would probably have been opposed at the sites that had always been considered the most suitable for the erection of a lock and weir of the usual type, the cost of the foot-bridge necessary for the working of Mr. Stoney's sluices was one of the objections to the scheme, and remained so for some time. At last, one day it came into my mind that if we had the courage to adopt the present site for the scheme, the bridge would be of great service in affording improved communication with Isleworth and St. Margaret's, where only ferries existed, and there being a highway on the Middlesex side, the objections of the landowners would not be encountered, and no compensation demanded. Moreover, the river here was broad, and its course straight, which the scheme required, on account of the scour of the sluices when shut, and the passage of the river traffic when open.

After making these suggestions to Mr. Burt and Mr. Thrupp, a meeting of the committee and several engineers again took place at my house, to view the site, and decide upon a scheme. The difficulty that remained was the unsightliness of the sluices when not in use. I had suggested turning them over, and lowering them into a recess in the bed of the river, to which, however, there were objections, when a member of the committee asked if they could not be turned up instead. To this Mr. Stoney replied that he had thought of a plan which would enable him to tuck them up under the arches of the bridge, so that they would be out of sight. His suggestion and method of carrying it out met with the approval of all present, and before the meeting terminated, the problem was considered solved. With his ready resource, Mr. Stoney overcame difficulty after difficulty as they presented themselves, and soon produced a very practicable scheme, of which an excellent working model was made.

I shall not be able to dwell at length on the Parliamentary proceedings, which, under the skilful guidance of Mr. Charles Burt, who I have personally to thank for presiding here this evening, were admirably carried through to a successful issue. Only those connected with the promotion of the scheme know the amount of energy, labour, and thought he brought to bear upon the subject, and there can be no doubt that to his ability and knowledge of Parliamentary procedure was due the passing of the Bill. There were no less than 15 petitions lodged against the Bill in the House of Commons, and the evidence was so voluminous that it occupied ten days; whilst there were nine petitions against it in the House of Lords, which took up the best part of six days.

I ought to mention that Mr. Thrupp suggested that the local authorities should be made the promoters of the Bill, and the consent of the ratepayers having been obtained, under the Borough Funds Act, in Richmond by an overwhelming majority, and in Twickenham by a very substantial majority, the Bill went forward with the full sanction of these parishes.

The Heston and Isleworth Local Board held a meeting for the purpose of opposing the Bill with the ratepayers' money, because Isleworth was disappointed that the site selected was situated above the town; but the vote of the residents of St. Margaret's, a small portion of the district benefited, was solid enough to decide the question in favour of the scheme. The estimated cost of the works was £40,000, and this sum was fixed by the Act to be contributed by the districts rated.

As soon as the Royal Assent was obtained, on August 14th, 1890, the Thames Conservancy Board met to consider the provisions of the Act, which provided that, if they were unwilling to accept the construction of the works themselves, within a period of six months, the local authorities would become empowered to undertake them. Within the time specified, they intimated their acceptance of the responsibility, and proceeded to purchase plant and make provision for the construction of the works.

Mr. More, the engineer of the Conservancy Board, promptly took in hand the working drawings, and suggested improvements in the design of the foot bridge, and an enlargement of the lock, which considerably enhanced the estimated cost of the work. It took a considerable time to erect landing stages, cranes, &c., the first pile being driven on July 1st, 1891. The concrete foundation of the first pier was put in on March 25th, 1892, and the works have proceeded steadily ever since under the able superintendence of Mr. Le Neve Foster, the engineer-in-charge.

The abutments and piers of the bridge are built of Staffordshire blue bricks faced with Cornish granite. The lock is to be 250 feet long, and the gates give a clear opening of 26 feet; but to accommodate a tug and full complement of barges, the lock widens out on the shore side to 37 feet for about two-thirds of its length. The work in this section is from five-eighths to three-fourths finished.

A good idea of the appearance of the bridge will be obtained from the photographs showing the sluice in the water, and also raised and turned over between the platforms of the two footways of the bridge. This arrangement avoided the footways being raised unnecessarily high, and, when the cornice and handrail is fixed, the sluice itself will scarcely be visible at all.

The whole of the bed of the river is laid bare in sections between the foundations of the piers by means of half-tide coffer-dams, which have to be pumped out for each day's working. A wide and deep concrete apron is formed between the rows of sheet piling on either side, which are driven deep down into the bed of the river, and in the centre is laid a granite sill, on which the sluices would rest, if they were let down to their fullest extent; but, as I shall presently explain, they are suspended by counterbalance weights, and kept floating by the head of water, maintained just sufficiently to allow all the stream that comes over Teddington weir to pass underneath. When first brought before the Committee of the House of Commons, the design of the bridge had seven arches of 40 feet span, five of which were to be fitted with sluices, whilst the side arch on the Middlesex side was to be fitted with rollers, as a slip-way for pleasure boats, and the lock built under the arch on the Surrey side.

The largest sluices that had then been made were 30 feet span, and Mr. Stoney was afraid to propose a much wider span in case he might be thought to be too bold, although fully convinced in his own mind how much simpler the scheme would be with fewer spans.

Opposition evidence having been brought to show that it was now the modern course of engineering to increase the spans of bridges as much as possible, Mr. Stoney at once offered to increase the width of the sluices, and reduce the number of spans over the stream to three, and the plans were so altered when taken before the House of Lords.

I will now describe the mechanical part of the structure, which has been constructed at Messrs. Ransomes and Rapier's Works, Ipswich, where the sluices for the Manchester Ship Canal were also made.

The three spans over the river are actually 66 feet wide, the side arches over the lock and slipway 50 feet each, and the clear headway under each arch is 1 foot more than at the Richmond Railway-bridge.

The sluices which fill the spans are made entirely of steel, with the exception of the end-bearings, and the trunnions upon which they

turn from the vertical to the horizontal position when raised out of sight. The sluices are 12 feet deep, and each weighs 32 tons, being suspended at each end by four steel-wire ropes 1 inch in diameter. The steel-wire ropes pass over pulleys attached to the lifting-gear, and to the other ends of these are attached the counterbalance weights. There are four, of 8 tons each, suspended in 3 feet square wells made of steel plates built in the masonry, and recessed one on either side of the end of each sluice, two wire ropes being connected to each. The steel wells also serve to support the guides and bearers, which are planed surfaces of cast-iron, between which and the bearers of the sluice are interposed Mr. Stoney's patent rollers, which will receive the static pressure of the water when it is impounded. There is a set provided on either side, so that, no matter whether the stream is flowing up or down, the friction from the pressure which would otherwise result is almost entirely eliminated. The rollers are suspended independently with counterbalance weights of their own, and travel slower than the sluice, having less distance to cover, and are

Arch of Bridge with Sluice down.

always ready to take the strain, when the sluice descends to the point at which they stop.

The counterbalancing of the sluices is so perfectly adjusted, that the buoyancy of a balk of timber running along the top of the up-river side of each sluice is sufficient to float it, and cause it to ascend with the rising of the tide. When the scheme is in operation, it will regulate automatically the flow of the stream under the sluices at low water, and maintain a nearly fixed level after the period of half-tide is reached, and the sluices have been lowered. In addition to the large counter-balance weights, there is a link-chain arrangement on either side carrying small weights, which provides for the adjustment and difference in weight of the sluice in and out of the water, and according to the extent to which it is submerged. The turning of the sluice from its vertical to the horizontal position is accomplished by means of a wrought iron arm, projecting from one end of the sluice, carrying a small pulley, which travels in a curved guide on the upper side of the pier of the bridge.

The lifting gear is similar on either side,

motion being imparted to the pulleys over which the suspending wire ropes pass in the usual manner. The windlass is only attached to one set of gear, and, in order that they should work quite simultaneously, the power is conveyed by means of a 5 inch shaft and spur gearing from one side of the arch to the other.

On the land pier of the bridge, on the Surrey side, accommodation will be provided for the lock-keeper and his assistants, and similar rooms will be built for the toll-collector on the other side, near the slipway. Being arranged under the staircases leading to the foot-bridge they will not be much seen, and have rather a good effect in giving solidity to the land arches.

The Act provides that the sluices shall be worked so as to hold up the water of the river above the bridge to as nearly as may be 5 feet 9 inches below Trinity high-water mark.

The sluice usually occupies about three minutes in lifting when worked by two men, but it can be done in much less time with quick gear, and it is very interesting to see such a huge mass of metal (probably the largest in bulk if not the heaviest that has ever

Arch of Bridge with Sluice raised and turned over.

been lifted in a similar manner) gradually rise out of the water in which it was previously suspended floating, and after closing the 66-feet opening of the arch, and eclipsing the view of the landscape for a time, disappear above the arch, leaving the river as free as if it only were spanned by an ordinary bridge.

DISCUSSION.

The Chairman said that there were three machines which, to his mind, were necessary to the success of the enterprise. First of all, there was the photographic machine, and he thought every one would agree with him that Mr. Hilditch was a complete master of that. The next was the engineering machine, of which Mr. Stoney was the master. This gentleman had designed the bridge, which was so simple in its arrangements that it was a wonder other persons had not thought of it before. The third machine which was wanted was the Parliamentary machine, and this turned out to be the most difficult of all. He might take a wrong view of it, seeing that this was the machine which he had to work. It was a difficult machine to bring into operation, especially when they had the dead weight of whole of the Thames Conservancy against them. The

Thames Conservancy was a powerful body. It was a wealthy body, although it professed to be a poor one. That body was wealthy in this sense, that they had the power to raise money if they needed to raise it, while the inhabitants of Richmond were a comparatively poor people, and were not able, out of their slender means, to find such amounts as were necessary to deal with an enterprise of this kind. In the House of Parliament there was a tribunal where even the weakest might be heard, and if they had a solid foundation for any complaint, they were usually successful. With regard to this particular case, Mr. Hilditch had not mentioned one element, which was of great importance, and that was that they had had a good working model. This model had impressed everybody who saw it. The first time it was produced in public was at the "Star and Garter," when the Duke and Duchess of Teck and Princess May were present. To this model he attributed very largely their success in the House of Parliament. The witnesses they produced before the committee were the photographs, which spoke to everybody, and what was more, they could not be cross-examined. Mr. Hilditch was present to be cross-examined, but as he was a thorough master of the subject, he was perfectly ready to undergo that ordeal. Sir Theodore Martin, the Parliamentary agent, said, after the Bill was passed, that he thought it was the most impudent Bill that had ever been brought into Parliament. No doubt it was, but it was backed by a solid foundation of the right of the people of Richmond to the use of a river on which their town was built. The cost of the Act to the promoters was £4,300, of which £1,200 went to the gentlemen of the long robe and £900 to the engineers; £1,500 was raised by subscriptions. The inhabitants of Richmond felt very deeply the necessity of some such scheme, or they would not have been willing to subscribe the amount. The Act gave power to rate all properties within 100 yards of the river at a double charge of 4d. in the £. The cost of the work was estimated at £40,000, but in the hands of the Thames Conservancy, who never did anything unless they did it well, and at a costly sum, it would cost £60,000. If the Thames Conservancy had not done the work the inhabitants of Richmond would have done it for them. He was very glad when the Conservators looked at the matter broadly, after having been beaten in two fights. They said, "Parliament has now relieved us from the responsibility of altering our treatment of the river. It has said, 'This thing shall be done,' and it is now our duty, as Conservators, to carry out what Parliament has ordered." This was a statesmanlike way of looking at the measure, and they had now decided to do it, and to do it properly. Speaking as a Richmond man, he felt that they had started an enterprise which was not going to end at Richmond. He could not help thinking that, when the beautiful scheme was shown in practical working order at Richmond, many people in other parts of the country would avail themselves of the invention; and he hoped that Mr. Stoney would derive a handsome return for the ability and ingenuity he had displayed.

The ASSISTANT SECRETARY read the following letter from Mr. R. W. Peregrine Birch :—

"DEAR SIR,—A bad cold, which has taken away my voice, prevents me attending the meeting to-night, as invited. If I could have been present I should have pointed out that the introduction of Mr. Stoney's sluices on the Thames below Richmond will be found to have an importance far greater than the local object which brought them into existence would imply. It has now been practically admitted by both sides, in the great controversy as to whether London shall take more water from the Thames or not, that any mischief which would otherwise accrue would be prevented if the present dry-weather flow could be artificially maintained during the lowest four or five hours of each tide in the reaches just below the weir Mr. Stoney is now erecting. It will be evident, from the dimensions of the river, that by judicious manipulation of the new weir, and without varying the prescribed water-level above 12 inches, an increased supply to the reaches below, exceeding 5,000,000 gallons an hour, could be maintained for five hours. This would enable 120,000,000 gallons more water than at present to be sent to London in the twenty-four hours, without injuring the navigation. And by applying the same system to Teddington Weir, and the reach above, the effect could be about doubled. I would be glad that this should be taken as my contribution to the discussion to which you were kind enough to invite me.

And am, dear sir,
Yours faithfully,
R. W. PEREGRINE BIRCH."

Sir H. Trueman Wood.

Mr. W. SMARTT asked what would the result of keeping the water back. There was a time when the river used to be tidal to as far as Kingston, and he could not see any reason why this scheme should not be brought much lower down. He thought that when the Thames water was kept still for a given time, a large quantity of mud would be deposited, as had occurred at Tilbury Docks, costing the Docks Company a very considerable amount to clear it away. If a large quantity of water was kept stationary, he understood that there must be a large quantity of mud deposited; he thought it was probable that the time would arrive when the space up to the lower construction would be occupied by sediment. A large quantity of water in the upper part of the Thames was drained from the chalk and other sources, and every one knew that the water companies were adding to the number of artesian wells, with the result that

he water in the chalk was being lowered considerbly beyond the supposed level.

Mr. F. K. MUNTON asked what was the average lepth at low tide in the middle arch? He should lso like to know what was the quantity of water vhich it was intended to impound beyond the high-evel mark. The general impression was that, when he sluices were lowered, they would only remain there s long as the water above and below the weir was ot at the same level. Immediately the tide rose to height level with the sluices, were the sluices to be aken away, or would they always impound one height f water? He thought that the inhabitants of Richnond and Twickenham were all interested in this neasure, but, in addition, 99 out of every 100 inhabitnts of London were also interested in having a lake t Richmond, that being the playground of London. Ie had always heard that Mr. Hilditch was an nergetic man, and while he continued to keep an ye upon what was being done, it would be a success.

Mr. C. J. MORE, in reply to a question by the Chairman, said that, at the rate the Thames Conervancy were now going on, he hoped the works vould be finished by next November. The level t which it was proposed to impound the water was t a height of 5 feet below ordinary spring-tides. The sluices would be adjusted so as to allow any urplus water to pass. As the tide flowed below and eached the level, then the sluices would be drawn p. When the water had reached the level of ft. 9 in. below Trinity high-water mark, the sluices vould be lowered and regulated according to the uantity of water coming down.

Mr. MUNTON asked what was the difference between the maximum and the minimum level of npounded water.

Mr. MORE replied that it would be kept at one teady level.

Mr. F. C. M. STONEY said that, as questions had been asked as to the deposit of mud, he might say that e thought the origin of the question arose from a mistaken notion of the scheme. A number of people gave evidence against the Bill who had but very little onception as to what the appliances were. The question of the deposit of mud could only arise in he case of an old-fashioned fixed weir; it was simply because the weir was not fixed that they obtained heir Bill. There could be no stagnation. The tidal vater was retarded, but the land water would be llowed to flow naturally and automatically, precisely n accordance with the requirements. That operation ad been tried on the part already erected, and so ne was the machinery, that one could hardly see a novement in the sluice; but, if anyone put his hand pon the handle of the multiplying gear at the top, was moving sometimes rapidly and sometimes slowly, according to the motion on the gate. The height of water maintained for boating purposes was practically of an uniform height, but that height theoretically varied a few inches, according to the quantity of land water coming down. The sluice was supposed to shut within eight inches of the bottom, but, if that was not enough for the flood water coming down, then the sluice would gradually rise a little. He had been for over 25 years working out the problem of how to overcome the difficulty suggested at Richmond, and when he proposed large spans for big sluices, he was laughed at. As to the question of large spans he was not, himself, afraid of proposing them, but when it was suggested that 40 feet spans would be safer than 70 feet spans, he fell in with the suggestion, notwithstanding that his original idea was to have 70 feet spans, as he considered they would not cause any check to navigation. At the present moment, he had been asked to design some 200 sluices for the Nile, in Egypt, which he hoped one day to carry out. He merely mentioned this to give an illustration of the difference between the depth of spans. At Richmond, the differential depth was very small. The sluice would only have a possible load of 70 tons, whereas on the Nile each door would have a load of 440 tons, and a head of water of 73 feet. The necessity for turning the sluices over had not occurred to him until it was mentioned that it would be a disfigurement to have them hanging down. His rule was always this, that if any proposal was not against mechanical law, it could be done, though when it was first mentioned to him, he had not the least idea how to carry it out, and that was the simple reason, when asked about it, that he would not say how it could be done. There were considerable difficulties in turning over the sluice on account of the rollers hanging vertically while the door turned over; but, after thinking over it, he very soon found a way out of the difficulty. As regards the mechanism, there was nothing that could be more simple. The whole plan was deduced from two laws, first that there was nothing that you could put into a river which improved it, and that you could not interfere with a river without restoring an equivalent to it. If he wanted to put up a structure his first idea was to improve the area. French engineers had an idea that a fixed weir was not permissible. They thought that everything should be moveable, but they had always gone to work the wrong way in shutting everything down into the water. The needle weir, which had been referred to by the reader of the paper, was a most dangerous apparatus, many men having been killed while operating them.

The CHAIRMAN said he had omitted to mention that the difference between the estimated cost of £40,000 and the probable cost of £60,000 was to be borne by the Thames Conservancy. Richmond, Twickenham, and the neighbourhood having spent

about £200,000 in excluding their sewage from the Thames, with a view to making the river sweet, were entitled now to claim a share of the water, which he thought by means of the sluices now under construction they would obtain. In conclusion, he proposed a hearty vote of thanks to Mr. Hilditch for his able paper.

The motion having been carried,

Mr. HILDITCH said that there were hardly any points for him to reply to, as the most important questions raised had already been ably answered by Mr. More and Mr. Stoney. The point mentioned by Mr. Peregrine Birch, as to impounding the water for a time and letting it off afterwards, opened up a very wide subject. When they came to work the sluices no doubt they would find some benefit to be derived n that way. He did not like the idea of the scheme being used to enable the water companies to further deprive the Thames of the water that they should obtain elsewhere. The improvement of the river below was another matter. It might be found possible to work the sluices so that some of the tide could be saved at first and distributed afterwards, and thus be the means of keeping the bed of the river in a better condition. With regard to any deposit of mud, he considered the scour of the river would be sufficiently great to prevent this.

Miscellaneous.

THE PARIS FIRE BRIGADE.

At the close of the year 1890, there were 203 telephone fire-alarms in Paris, with 409,566 mètres of wires. The *état-major* of the regiment composing the fire department, situated at 9, Boulevard du Palais, the centre of the general system, is connected with twelve barracks, and through these with 124 relief posts or stations. It is, besides, connected with seven steam fire-engine stations. The United States Consul-General at Paris says that there is under construction, at the present time, a new network, or system, of public fire-alarms. These new lines are already partly completed within the limits of four barracks; they connect 112 public fire-signals by means of 95,033 mètres of wire. There are, besides, 182 private alarms, with 171,984 metres of wire. In each post or barracks there is a fireman telegraph operator on permanent duty, whose special mission is to receive and transmit the alarms of fire. The Paris fire department consists of a regiment called the *Regiment des Sapeurs Pompiers*. This regiment, maintained at the expense of the city of Paris, belongs to, and is under, the War Department, so far as concerns organisation, recruiting, military command, discipline, promotion, reward and interior administration. The services, howeve of the regiment, as pertaining to fires, are under th direction and orders of the prefect of police. Th regiment is commanded by a colonel, and comprise two battalions of six companies each. There are 5 officers, and 1,693 men, making a total of 1,744. Th 12 companies are lodged in 12 barracks, situated i different parts of the city, and each has a certai portion or section of the city under its more direc protection. In each of the barracks the service i assured for each period of 24 hours by a picket c men under the orders of an officer, and conveye to the scene of the fire by vehicles carrying th necessary apparatus. These vehicles are the apparatu waggon, long ladder, steam-engine, and cart. Th picket, with the apparatus waggon and the lon ladder, form the first equipment sent to the fire. Th apparatus waggon carries a reel with 320 metres o heavy hose, 120 mètres of light hose, apparatus fo extinguishing cellar fires with air compressors, an a life-saving apparatus. As soon as the equimen has started, a second one is immediately formed ready to respond to a new call. The second equipment comprises two hose cases, containing 20c metres of hose, one hand-engine, and one *caisson*, with life-saving apparatus. Each barrack is furnishec with (1) a steam fire-engine, which always accompanies the first contingent sent to a fire at night, anc which, in the day time, serves for fires of some magnitude, and also to increase the water-pressure in those parts of Paris where such pressure is insufficient; (2) a ventilator, which is used to ai localities, containing injurious or explosive gases; (3) an apparatus for life-saving in wells, pits, &c.; and (4 safety lamps. At the end of 1891, which is the lates year for which statistics are available, there were 12 steam fire-engine stations, of which five were at the barracks, and seven at isolated stations. At each of these stations there is a steam-engine and a *caisson*, with 720 mètres of hose and the life-saving apparatus. Every twenty-four hours each of the barracks sends a detachment of its men to a certain number of posts or stations situated in that section of Paris over which the respective barrack has special guard, these detachments of firemen being installed in localities hired for the purpose from private property owners, or in public buildings. These posts are required to respond to every requisition of the police, or of the public, for service in extinguishing fires or saving life. The number of men stationed at these posts varies from one to eight. The apparatus consists of one or more hand-hose carts carrying each 160 mètres of hose, which the firemen attach to the fire-plugs by means of special couplings. In the districts of Paris where the water pressure is insufficient these posts are furnished besides with hand-engines, for increasing the water pressure. There are, at the present time, 124 city posts. In the public buildings there is generally provided a special canalisation of water under pressure, with safety fire-plugs placed at points

xposed to danger, and furnished with fixed pipe and ιozzles. For the theatrical performances, the barracks send a contingent of firemen in proportion to he importance of the establishment, from one to hirty men, and they are on duty especially in the ιart of the building occupied by the stage and cenery. To combat any outbreak of fire there are ιermanent fixtures with water under pressure installed ınder the direction of the officers of the corps. [he system of water supply for fire purposes is he following. In the public streets, the firemen mmediately find water by opening special fire-plugs. [his system, established in 1872, now comprises ,500 fire-plugs, the number provided for being ,200. When they shall all have been put in, they vill be about 100 mètres apart. They are branched ɪn to the distributing mains of water under pressure, from the rivers Seine, Marne, and Oise. In nost of these fire-plugs the water pressure is ufficient, so that the aid of the engines is not ɪecessary. All causes of fire are investigated by the *commissaires de police*.

THE PRODUCTION AND USES OF ASBESTOS.

The *Journal de la Chambre de Commerce de Constantinople* says that the best asbestos comes from Siberia; it is also met with in the clefts of certain rocks in the Tyrol, in the Pyrenees, in the mountains of Hungary, in Greenland, Brazil, &c. The finest description comes from Tarantaise in Savoy, and forms filaments exceeding fifty centimètres in length. In the Alleghany and Appalachian mountains there are important beds of this mineral, and veins of it are frequently found about fifty centimètres in thickness. Canadian asbestos is also of a very superior quality. On the St. François river there is a bed sixteen hundred mètres long and of unknown depth. In olden times asbestos was spun and made into tablecloths, serviettes, &c., which were cleaned by being passed through the fire, and this material was also used by the ancients to wrap round corpses before placing them on the funeral pile, in order that the ashes might not be mixed with the wood. In the Vatican Library, at Rome, an asbestos shroud can be seen which contains ashes and half-burnt bones, with which it was found in a sarcophagus. The ancients also made wicks for funeral lamps of the material. In modern times, asbestos has been used for firemen's clothing, and for fire-proof paper. More recently, in America, its employment has greatly increased, and it is now used as a substitute for minium and caoutchouc, in connection with the machinery in steamboats and locomotives. Asbestos tissues, manufactured with pure amianthus yarn, are employed by the manufacturers of chemical products in filtering acids, and as wicks in certain heating apparatus. Asbestos mastic has an advantage over all known mastics, and resists the very highest temperature without injury. Asbestos colours are manufactured which, in the case of metals, form an excellent preventive of oxydation, and render wood and tissues absolutely incombustible. Bricks, made of very light and porous asbestos, are frequently placed in gas chimneys; the mineral reddens, and throws out a great heat. About 12 years ago, not more than three or four articles, at the most, were made of asbestos, while, at the present day, the list contains more than a hundred, and the use of this article is extending everywhere. One of the uses to which asbestos is now put is in connection with ceramics, and the use of asbestos pottery is expected to become popular, and to spread. With asbestos powder a species of earthenware is manufactured, of which the results, from an industrial point of view, are very interesting. This earthenware has the peculiarity of possessing a grain of a fineness hitherto unattained by any china ware. Its colour varies according to the treatment to which the asbestos has been subjected; it most frequently approaches that of terra-cotta, and this article unvarnished is used for the production of statuettes and other articles. On earthenware prepared from asbestos, enamel is easily applied, and, when finished, presents a very attractive appearance. Employed as filters for water, wine, beer, alcohol, &c., the results are superior to any obtained by other descriptions of earthenware. Uninjured by acids, they can be used for the strongest, and as insulators they are much superior to glass. Finally, as pipe-clay, asbestos produces an excellent pipe, and it is said that no clay yet used with this object has produced so satisfactory a result from the smoker's point of view. It is only a very short time that asbestos earthenware and pottery has been known, and already its applications are found to be very numerous. Each day appears to find a new discovery in the quality of the ware and a new industrial application. As regards the method of preparation to which asbestos is subjected, particularly in Canada, the following is adopted. After having been examined, the blocks of asbestos are pounded in such a manner as not to break the fibres, and these latter are then submitted to the action of a species of sieve, in order to separate the long from the short fibres. The long fibres are treated almost in the same way as ordinary textiles, with this difference that as they cannot be felted they must be subjected to a process of "concentration" before being spun. It is this that renders the manufacture of fine asbestos tissues extremely difficult.

MANUFACTURE OF SILK FROM WOOD PULP.

In a recent report by the United States Consul at St. Etienne, some additional details are given of the Chardonnet process of making silk from wood-pulp. For a long time after its discovery, the process and

system of M. de Chardonnet remained concealed in his laboratory. It made its first appearence at the Exhibition of 1889, where it received the highest award the jury could give. Connoisseurs, savants, and manufacturers were greatly interested in it, although it had not reached the degree of perfection to which it has now been brought. The great question was, since the new invention tended to produce a revolution in one of the greatest of French industries, could this discovery be utilised for the growing needs of the people, and a complete answer in the affirmative has been given by M. de Chardonnet, who has already, by enlisting the sympathies of several business men, bought a mill at Besançon, where the silk is being manufactured. The raw material is made from wood-pulp, such as is used for the fabrication of certain kinds of paper. This pulp is carefully dried in an oven, and plunged into a mixture of sulphuric and nitric acids, then washed in several water baths, and dried by alcohol. The product thus prepared is dissolved in ether and pure alcohol, and the result is collodion, similar to that used in photography. This collodion, which is sticky and viscous, is enclosed in a solid receptacle, furnished with a filter in the lower end. An air pump sends compressed air into the receptacle, and by its pressure the collodion is passed through the filter, which removes all impurities, and flows into a tube placed horizontally. This tube is furnished with 300 cocks, of which the spouts are made of glass, and pierced by a small hole of the diameter of the thread of a cocoon as it is spun by the silkworm. The spinner opens the cock, and the collodion issues in a thread of extreme delicacy. It takes six of these threads to make a thread of the necessary consistency for weaving. This thread is not, however, fit to be rolled on the spools, by reason of its softness and stickiness; the matter is as yet collodion, and not silk. To produce the necessary hardness, the inventor resorted to a very ingenious but simple method. The little glass tube, already mentioned, is surrounded by a small reservoir of the same material constantly filled with water; when the thread issues from the aperture in the manner described, it traverses this water, which takes up the ether and alcohol, and then the collodion becomes solidified, that is to say, it is transformed into an elastic thread as resisting and brilliant as ordinary silk. On account of the materials employed in the manufacture of this silk, wood, ether, and alcohol, it might be rightly supposed that the stuff manufactured would be dangerously inflammable. M. de Chardonnet has apparently obviated such a contingency by plunging the spun thread in a solution of ammonia, thus rendering it as slow of combustion as any other material. Consul Loomis says that this discovery seems to have a great future. He has talked with a great many silk merchants, brokers, dyers, and manufacturers, about the Chardonnet method of producing raw silk from wood, and it is universally admitted that the process will eventually yield large practical and profitable results, and a great step has been made towards thi[s] end in reducing the inflammability of the Chardonne[t] silk. Another practical difficulty to be remedied i[n] the invention is the frequent snapping of the slende[r] threads issuing from the cylinder by reason of un[-]equal pressure. This makes it impossible to maintai[n] a standard quality for the output, and consequentl[y] there may be produced five pounds of excellent sil[k] followed by five pounds of a comparatively worthles[s] quality. Consul Loomis, in conclusion, says:—"U[p] to the present time none of the rich and importan[t] silk merchants of St. Etienne or Lyons have investe[d] heavily in the Chardonnet enterprise. They al[l] profess to believe in it, and declare that in a fe[w] years artificial silk produced by this process, when i[t] shall have been somewhat improved in certain details is destined to figure largely in the commercial world The disposition on the part of the capitalists is t[o] await development. When the process is once per[-]fected, and its results are wholly satisfactory, ther[e] will be a severe struggle for the control of this valu[-]able invention, and there seems to be no doubt of th[e] ability of the inventor to remove every obstacle which stands in the way of perfect practical success."

Obituary.

Sir James Anderson.—The Society is deprived of a well-known member by the death, on the 7th inst., of Sir James Anderson, who was elected in 1872. The deceased was born at Dumfries, in 1824, and entered the mercantile marine at an early age. He rose to the position of captain, and, it is understood, commanded the first screw steamship built by the Cunard Company for their American Service. He will be best remembered by the general public as commander of the *Great Eastern*, while that vessel laid the Atlantic telegraph cable, his share in the work having secured for him the honour of knighthood. For almost thirty years he had been engaged in business pursuits in the City, and was connected with many telegraph cable companies. He was the author of a work entitled "Statistics of Telegraphy," and of several papers.

Walter T. Glover.—Mr. Walter Glover, senior partner in the firm of W. T. Glover and Co., electrical wire and cable makers of Salford, died on the 27th April. The *Electrician* says of Mr Glover:—"He was one of the few men who had the boldness to think and to say that the much-abused Electric Lighting Act of 1882 did more good than harm, inasmuch as it prevented the perpetration of a lot of crude electrical engineering." The same paper adds that he was one of the first "to realise the necessity for accurate tables of the resistance and weight of electrical conductors; and his tables practically held the field until the intro-

ıction of the standard wire gauge." Mr. Glover, ho was born in 1846, had been eleven years a mem- ɜr of the Society.

Notes on Books.

:NGINEERING: an Illustrated Weekly Journal. Edited by William H. Maw and James Dredge. Double number.

On the 21st ult. a large double number of *Engineering* was published. The first part consisted f an elaborate and exhaustive account of the construc- ion of the Cunard Royal Mail twin screw steamers *Campania* and *Lucania*, while the second and longer ortion was devoted to a full description of the Chicago Exhibition. A special edition, bound in tiff covers and printed on superior paper, has now ppeared. The greatest possible care seems to have een taken to make both divisions complete, and the llustrations are very artistic. The article on the ıew steamers opens with a sketch of the Cunard ine, and subsequent chapters treat of the design of he vessels, the building of the hulls, the engines, the oilers and feed arrangements, the electric lighting, he navigating appliances, passenger accommodation, &c. In the article on the Exhibition, the Editors explain that their aim is not only to give those of heir readers who may be unable to see the World's Fair an idea of what it is like, but also to afford some guide to those who propose making the journey to Chicago.

General Notes.

COTTON SPINNING IN JAPAN.—According to the report of the Japanese Cotton Spinning Mills Association, 307,398 spindles were at work during the first month of the present year. During that period the quanity of yarn spun by these mills amounted to 6,262,725 lb., giving employment to 262,280 men and women.—*Industries.*

ART FURNITURE EXHIBITION.—The Lord Mayor of London, on the 5th inst., opened the Shoreditch Art Furniture Exhibition, organised by the Shoreditch Vestry, in the Town-hall, Old-street, in connection with the Shoreditch Municipal Technical Schools. The schools are in Hoxton-street and belong to the Shoreditch Vestry. They are maintained out of the income derived by the Vestry from the advertisements on the street lamp-posts, amounting to £400 a year. If the work of the school is to be continued £200 is required and about £450 for tools, &c. The London County Council is to be asked to contribute the difference between the pres' t income and the expenditure. The Exhibition consists of two sections, the first being a loan collection of antique wood-carving and furniture from the South Kensington Museum and private owners, while the other section consists of modern articles made in Shoreditch and the neighbourhood. There are 290 exhibits in the large hall and council chamber.

THE TELEPHONE.—The largest centre of telephonic communication in the United Kingdom, and one of the longest in Europe, is that of Liverpool, where the National Telephonic Company has just completed its new switch-room. This is a hall 90 feet in length, which is fitted in a way that completes nearly a million telephonic connections, whereby each subscriber on the Exchange may be placed immediately in connection with any other throughout the country. Already there are worked from the Liverpool centre 9,600 miles of line, of which more than 7,000 are Exchange and private wires. In 1882 the mileage of wires in Liverpool was only 463 miles; in February last it was 7,019. The number of calls in the Liverpool centre is 42,800 per day, representing a daily communication between 85,600 persons.—*Iron.*

RAILS IN THE UNITED STATES.—In consequence of the great development of the American metallurgical industry during the last decade, the Americans are now using scarcely any foreign rails. Formerly they imported European rails (and especially British rails) upon a liberal scale; but now they practically supply their entire rail requirements. In 1870 the consumption of rails in the United States was 969,958 tons. In 1875, the total stood at 724,963 tons; and in 1880, at 1,564,756 tons. In 1885 it declined to 979,167 tons. Since 1885 it has moved on as follows year by year:—1886, 1,642,125 tons; 1887, 2,277,469 tons; 1888, 1,459,980 tons; 1889, 1,527,755 tons; 1890, 1,885,489 tons; 1891, 1,307,429 tons; and 1892, 1,500,347 tons. In 1870, the imports of rails into the United States amounted to 356,387 tons. In 1875, the total stood at 17,364 tons; and in 1880, at 259,544 tons. In 1885, it had sunk to 2,189 tons. Since 1885, the imports have moved on as follows year by year:—1886, 41,588 tons; 1887, 137,829 tons; 1888, 56,280 tons; 1889, 5,551 tons; 1890, 182 tons; 1891, 253 tons; and 1892, 347 tons. Of course, the construction of new railroads has a good deal to do with the consumption of rails in the United States. The progress made in the work of railroad establishment has fluctuated rather materially year by year. The greatest activity was observable in 1882 and 1887. In the former year 11,569 miles of new American railroad were built, and in the latter, 12,878 miles. On the other hand, in 1875, only 1,711 miles of new line were completed. Since 1885 construction has moved on as follows year by year:—1886, 8,018 miles; 1887, 12,878 miles; 1888, 6,916 miles; 1889, 5,146 miles; 1890, 5,498 miles; 1891, 4,262 miles; and 1892, 4,200 miles.—*Engineering.*

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at Eight o'clock :—

MAY 17.—F. E. IVES, "Composite Heliochromy." Captain W. DE W. ABNEY, C.B., F.R.S., will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m. :—

MAY 18.—SIR RAYMOND WEST, K.C.I.E., "Agrarian Legislation for the Deccan, and its Results." The RIGHT HON. SIR JAMES FERGUSSON, Bart., G.C.S.I., K.C.M.G., C.I.E., M.P., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings at Eight o'clock :—

MAY 16.—W. B. PERCEVAL, Agent-General for New Zealand, "Aspects of Federation." The EARL OF ONSLOW, G.C.M.G., will preside.

CANTOR LECTURES.

Monday evenings, at Eight o'clock :—

C. HARRISON TOWNSEND, F.R.I.B.A., "Mosaic: its History and Practice." Two Lectures.

LECTURE II.—MAY 15.—Revived interest in mosaic—Its method and materials—*Smalts*, or enamel—Its composition—Gold and silver *Tesseræ*—Their application—Cements—Lime and oil, various formulæ—Methods of work *in situ* and in the studio—Principles and lessons learnt from old examples.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 15 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. C. Harrison Townsend, "Mosaic: its History and Practice." (Lecture II.)

British Architects, 9, Conduit street, W., 8 p.m. Professor G. Baldwin Brown, "How to use Vitruvius."

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m. Professor Conn, "The Teleological Argument."

TUESDAY, MAY 16 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. W. B. Perceval, "Aspects of Federation."

Royal Institution, Albemarle-street, W., 3 p.m. Professor R. K. Douglas, "Modern Society in China."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. C. J. More, "Wreck-raising in the River Thames."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Mr. Henry Higgs, "Workmen's Budgets."

Pathological, 20, Hanover square, W., 8½ p.m.

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Mr. F. E. Beddard, "The Atrium and Prosta of the Oligochætous Worms." 2. Mr. G. Sowerby, "Descriptions of fifteen new Species Pleurotomidæ." 3. Mr. A. H. Everett, "List Mammals inhabiting the Bornean group Islands." 4. Mr. O. Thomas, "A Second Collection of Mammals, sent by Mr. H. H. Johnsto from Nyassaland"

WEDNESDAY, MAY 17...SOCIETY OF ARTS, John-stree Adelphi, W.C., 8 p.m. Mr. F. E. Ives, "Composite Heliochromy."

Meterological, 25, Great George-street, S.W., 7 p.m. 1. Mr. William Ellis, "Mean Daily Maximum an Minimum Temperature at the Royal Observator Greenwich, on the Average of the Fifty Yea from 1841 to 1890." 2. Mr. Frederic Gaste "Suggestions, from a practical point of view, for new Classification of Cloud Forms." 3. Alex. B MacDowall, "Notes on Winter."

Geological, Burlington-house, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m. 1 Sir David Salomons, "Exhibition with the Projection Microscope." 2. Mr. C. Rousselet, "Note on Rotifers."

Pharmaceutical, 17, Bloomsbury-square, W.C., 1 a.m. Annual Meeting.

Archæological Association, 32, Sackville-street, W. 8 p.m.

Botanic, Inner Circle, Regent's-park, 2 p.m. Summe Exhibition.

Inventors' Institute, 27, Chancery-lane, W.C., 8 p.m.

THURSDAY, MAY 18 ... SOCIETY OF ARTS, John-street Adelphi, W.C., 4½ p.m. (Indian Section.) Si Raymond West, "Agrarian Legislation for the Deccan, and its Results."

Royal, Burlington-house, W., 4½ p.m.

Chemical, Burlington-house, W., 8 p.m. 1. Messrs. W. A. Shenstone and M. Priest, "Observations on the Production of Ozone during Electric Discharge through Oxygen." 2. Dr. Shields, "The Relative Strengths or Avidities of Some Weak Acids." 3. Dr. James Walker, "The Boiling Points of Homologous Compounds." (Part I.)

Camera Club, Charing cross-road, W.C., 8 p.m. Sir David Salomons, "The Electric Microscope and Polariscope."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. R. Boodle Sharpe, "The Geographical Distribution of Birds."

Historical, 20, Hanover-square. W., 8½ p.m. Dr. F. Liebermann, "Instituta Cnuti aliorumque Regum Anglorum."

Numismatic, 22, Albemarle-street, W., 7 p.m.

FRIDAY, MAY 19...United Service Institute, Whitehall-yard, 3 p.m. Rear-Admiral S. Long, "The Pacific Ocean as a Theatre of Naval Warfare with Modern Steamships."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. Alfred Austin, "Poetry and Pessimism."

Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

SATURDAY, MAY 20 ... Royal Institution, Albemarle-street, W., 3 p.m. Dr. Henry Craik, "Johnson and Wesley."

The Telegraphic Address of the Society of Arts and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,113. Vol. XLI.

FRIDAY, MAY 19, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the Imperial Institute, South Kensington (by permission of the Executive Council), on Wednesday evening, June 21.

Each member will receive a card for himself, which will not be transferable, and a card for a lady. In addition to this, a limited number of tickets will be sold to members of the Society, or to persons introduced by a member.

Further particulars as to the arrangements will be announced in future numbers of the *Journal.*

PRACTICAL EXAMINATION IN VOCAL AND INSTRUMENTAL MUSIC.

The next examinations will be held by Sir Joseph Barnby, Principal of the Guildhall School of Music, and W. G. McNaught, A.R.A.M., Joint Examiners, at the House of the Society of Arts, and will commence during the third week in June. No names can be received after Saturday, May 27.

Full particulars can be obtained on application to the Secretary.

CANTOR LECTURES.

C. Harrison Townsend, F.R.I.B.A., delivered on Monday evening, May 15, the second of his two lectures on "Mosaic: its History and Practice."

On the motion of the Chairman (Professor W. B. Richmond, A.R.A.), a vote of thanks to the lecturer was passed.

The lectures will shortly be printed in the *Journal.*

FOREIGN AND COLONIAL SECTION.

On Tuesday evening, May 16, the Agent-General for New Zealand (Westby B. Perceval) read a paper on "Aspects of Imperial Federation, from a Colonial Point of View." The Earl of Onslow, G.C.M.G., presided.

The paper and discussion will be printed in the number of the *Journal* for June 2.

INDIAN SECTION.

On Thursday afternoon, May 18, Sir Raymond West, K.C.I.E., read a paper on "Agrarian Legislation for the Deccan, and its Results." The Right Hon. Sir James Fergusson, Bart., G.C.S.I., K.C.M.G., C.I.E., M.P., presided.

The paper and discussion will be printed in the number of the *Journal* for June 9.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, May 2, 1893; J. Hungerford Pollen in the chair.

The paper read was—

RUSSIAN INDUSTRIAL ART.

By E. Delmar Morgan.

Russian industrial art is so wide a subject, that to treat it properly would be quite impossible in the compass of one lecture. I propose, therefore, to take you with me through Russia, drawing your attention to certain points relating to her arts and industries.

My first experiences of Russia were at St. Petersburg, that capital which owes its existence to Peter the Great—a city of stately palaces, of immense squares, of handsome monuments, but with little distinctively Russian about it. St. Petersburg was the window from which Peter looked into Europe. When he came to the throne, Russia was in a non-progressive state, clinging to the past with its superstitions and traditions, and bearing the impress of the Tartar yoke. He determined to cut asunder the bonds which tied her to the East, and create a new Russia by opening the door to Western civilisation.

It has been said that Peter's reforms did more harm than good to his country, by interfering with her gradual development, that Russia, left to herself, contained all the elements of national greatness, and that it was too soon to polish her in accordance with Western ideas. However this may be, there can be no doubt that the genius of Peter raised Russia to the rank of a first-rate power, and that, had it not been for his reforms, she would have remained in a semi-barbarous state, a stranger to the arts, the industries, and the sciences of Europe.

St. Petersburg is a medley of Italian, French, German, and Dutch styles, or rather it has no architectural style about it. In its chief street—the Nefsky Prospect—you might imagine yourself in Turin, or Paris, or Munich, were it not that the painted sign-boards over the shop fronts, the dress and appearance of the people, and the mode of harnessing the horses, remind you that you are in Russia. St. Petersburg, however, contains magnificent public buildings, and many priceless treasures of art, stored away in palaces, museums, and private collections.

St. Isaac's Cathedral, designed and built by the French architect, Montferrand, with its five gilt domes, its monolith columns of polished granite, and its gorgeous interior, is a grand conception, carried out in spite of every difficulty. The design is foreign, the malachite and lapis-lazuli columns before the altar screen are hollow, the splendid mosaics are of foreign workmanship; yet the whole edifice is impressive, and has something distinctively national, if only in its vast proportions, and in the costly materials used in its construction. None but a Russian Tsar, the head of Church and State, could have, at so lavish a cost, erected so noble an edifice designed solely for the worship of God. Mr. Beavington Atkinson, in his work, "An Art Tour to Northern Capitals of Europe," says:—"The world owes its great cathedrals to the combined religious and temporal power." St. Petersburg — this northern Venice, as it is called—is in startling contrast with the squalor and poverty surrounding it. When once you are beyond the twenty-mile radius, and have left behind the capital and its elegant suburban retreats, you are in a wilderness of marsh and scrub wood, with here and there a village of dilapidated log-huts and a poverty-stricken agricultural population barely furnished with the necessaries of life.

The Hermitage, so called by its Imperial foundress, the Empress Catherine, is a palace of art, in its way as splendid as St. Isaac's. Its collections, comprising the famous treasures found at Kertch, are unsurpassed. Here are specimens of Greco-Scythian and other early arts, which have helped to build up the Russian art of to-day. What this Russian art is, and of how many elements composed, are questions upon which authorities differ. Besides Greco-Scythian, Scandinavian, Greco-Byzantine, Mongol, Indian, Persian, Central Asian, and Finnish, have been mentioned. To these have to be added the later influences of Western Europe: Italian, German, French, and English. With regard to Scythian, M. Vladimir Stassoff has pointed out, in the "Magazine of Art," that Mr. Alfred Maskell (who follows M. Viollet le Duc) in his South Kensington "Handbook of Russian Art," is wrong in identifying the nomadic Scythians depicted on this celebrated Nikopol vase with the ancestors of the Russians, for the Poliani-Kiani, whom Nestor mentions as the ancestors of the Russians, were a peaceful, agricultural people, altogether distinct from the warlike Scythians of Southern Russia, and Father Martinoff takes the same view.

Composed of so many and such heterogeneous elements, one might have supposed, that the native art would have altogether disappeared; yet, in spite of these adverse circumstances, there remains a substratum peculiarly Russian underlying the foreign superstructure. This native art may probably be seen at its best in the works of the young Russian school of painters, sculptors, and authors, in their efforts to attain realism, to make the canvas, the stone, the bronze, and the writing speak for them, and tell of the realities of Russian life. This realistic side of Russian art is exceedingly interesting, for studies of real life are often true to nature, while attempts at an ideal in religious art, for want of inspiration, fall short of the sublime.

There is hardly a cathedral, church, or monastery throughout the Empire that has not some traces of Greco-Byzantine influence. St. Sophia at Kief, with its mosaics of the 11th century, and the cathedral of the Assumption in the Kremlin, at Moscow, are examples of the earlier style. The plan of all these buildings is the Greek cross, a dimly-lighted, almost dark interior, walls painted with frescoes, a gorgeously decorated ikonostas, or altar screen, and a great central dome, or cupola. The general effect, during a religious ceremony, heightened by lighted tapers,

burning incense, the chanting of the choir, and the rich vestments of the priests, is very impressive.

While following Byzantine models in the general design, Russian architecture adopted a peculiar form of cupola, resembling an onion, altogether distinct from the domes of St. Sophia at Constantinople, St. Peter's at Rome, St. Paul's in London, and St. Isaac's in St. Petersburg. This bulbous cupola, said to be of Central Asian origin, and surmounted by a cross rising from a crescent, is characteristic of ecclesiastical architecture in Russia.

In decorative art, these same Byzantine influences, due to the close intercourse between Russia and the Eastern Empire before and after the introduction of Christianity, are equally conspicuous. They may be noticed in the silver pectoral crosses and other metal-work, the wood-carving, the embroidery on leather, and even in the textile fabrics. The English and foreign embassies which visited Moscow in the 16th century were much impressed with the gold and silver plate in the Tsar's palace. Some of this was doubtless brought as presents from foreign countries, some was the spoil of war, but the greater part was manufactured in Russian workshops. In 1880, our Government applied to that of Russia for permission to reproduce some of the numerous examples of English plate and other works of art in the imperial collections. The Emperor having graciously consented, a number of electrotype fac-similes were made and brought to England. These are exhibited in the galleries at South Kensington. They include vases, cups, flagons, salts, tankards, and jugs, besides a number of other pieces used at State banquets. Russian silversmiths' work has obtained a world-wide reputation both for elegance of design as well as for the purity of the metal used.

Enamelling on gold and silver is another art peculiarly Russian, derived also from Byzantine and Eastern sources. When Russian art ceases to be Eastern in character, it will have lost its claims to be regarded as a national art. Imitations of English, French and German designs, however skilfully made, for the Russian artificer is a good copyist, are, after all, only imitations. To form a true idea of Russian art, it is necessary to visit Moscow, Novgorod, Kief, and some of the monasteries and churches. But I must now say something of the manufacturing industries centred round Moscow.

Before the reign of Peter the Great, the industry of Russia was of a domestic, local character, and confined to villages. The chief articles of manufacture were woollen goods, cordage made of hemp, a coarse kind of linen, leather, metal-work, and articles made of wood. These were for home consumption as well as for export abroad. After the famous act of Boris Godounoff, obliging the peasants to give up their roving propensities and become fixed to the soil, the native industries greatly increased, that of leather especially benefiting. The leather industry was then centred in the governments of Kazan, Nijni Novgorod, Moscow, Yarozlaf, and Kostroma; tallow-melting works were also numerous; soap was manufactured at Kostroma; tar came from the district of Kargopol and the Vaga, where potash was also produced for export; Moscow wove cloth and silk stuffs, deriving the raw material from Persia; Kholmogory produced ironbound trunks and cases; Yarozlaf, small ironware; Tula was the small arms factory, a position it has retained to this day; from Vladimir came the ikons, or religious paintings on wood. As the demand sprang up for some new article, whole villages devoted themselves to its production, and these industries became hereditary, descending from father to son for generations. The next step was their organisation on the factory system, the domestic character of the industry being still retained. Thus, in the time of the Tsar Alexis Mikhailovitch, iron and bell foundries attained a certain degree of development. The government of Olonetz was the first seat of the native iron industry, now transferred to Southern and Eastern Russia. Gunpowder was then manufactured near Moscow; writing-paper and glass in the neighbourhood of Moscow. But the great impetus was first given to native industry by Peter the Great, who conceived the idea of planting the arts and industries of Western Europe in Russia. It is well known how he laboured himself in acquiring a practical knowledge of these arts in Holland and England. In Russia his efforts were untiring. He invited foreigners to come over, encouraged them to establish factories, protected these by all kinds of privileges, and, what was of the greatest importance, established government factories, to which villages were attached. The export of raw produce useful for manufactures was prohibited, the import of foreign fabrics limited. The Government became the chief buyer of the produce, often paying dearer than its value. Lastly, a separate

college was founded for the encouragement and protection of manufacturers.

By the end of Peter's reign, Russia numbered 250 manufactories, including almost every known branch of industry at that time. But the measures taken to bring these into existance were of an artificial nature, and gave rise to monopolies, the evil effects of which were felt for the fifty years succeeding Peter's reign. About 1770, however, notions of free-trade made their way into Russia, and led to a reversal of the protective system. The privileges were withdrawn, the college of manufactures was closed, and the foundations laid of a more normal development. It was not, however, till about the middle of the present century that free-trade began to exercise a marked influence on Russian political economy, the tariffs of 1850, 1857, and 1869 having gradually adopted a more moderate scale of duties, better suited to the requirements of the country. Nevertheless, many years will probably elapse before the protective system is entirely done away with, for the artificially-created industries of Russia have obtained so firm a hold that any sudden change might cause widespread distress and financial derangement.

The manufacturing industries may be grouped under the following heads:—

1. Textile fabrics, including those made of wool, flax, and hemp, cotton, silk with their contributory processes, such as gold thread and cloth of gold brocades, calico-printing, dyeing and bleaching, &c.

2. Products of wood, including builders' material, joiners' work, parquet flooring, turners' and coopers' work, articles made of bark, matting, tar, pitch, turpentine, &c.

3. Animal products, *e.g.* leather in all its branches, tallow, wax, hair and bristles, and miscellaneous articles, such as horn, bone, glue, and feathers.

4. Mineral products, such as bricks and tiles, pottery, china and porcelain, glass, chalk, alabaster, mortar and cement, stone-cutting and polishing, and pencils.

5. Metals, comprising cast-iron, wrought-iron, and steel, with their products, copper, and the precious metals with their products.

6. Chemicals, including dyes, potash, sulphur and sulphuric acid, vinegar, lacquer, cosmetics.

7. Tobacco.

8. Food products.

9. Miscellaneous, including carriages, musical instruments, straw fabrics, &c.

To examine all these in detail would take up far too much time. I shall, therefore, confine my remarks to those with which I have had some personal acquaintance.

The cotton industry, dating only from the middle of the last century, now occupies the foremost place among Russian industries. The first calico printing works was established in 1764; in 1793, the first spinning mill was started; in 1805, yarn was first woven by machinery at Alexandrofsk, near St. Petersburg. About 1820, this industry acquired some development in connexion with village industries, especially at Ivanovo, now a very important centre, where the commoner kinds of calico were woven under the superintendence of German artisans, at the beginning of this century. But the chief development of the cotton industry was due to the free importation of English looms in 1840. About that time (1843), my father founded the Petrofsky Cotton Spinning and Weaving Company, at Alexandrofsk, on the left bank of the Neva. About twenty years later when the number of cotton mills had largely increased, and the competition was much greater, he acquired by purchase the Schlüsselburg print works, situate on an island in the Neva, where this river issues from Lake Ladoga. Here, abundantly supplied with the purest water, and furnished with the most costly machinery that Manchester could supply, the Schlüsselburg Calico Printing Company, soon took rank among the first establishments of the kind in Russia. They are at the present day in full work, turning out an enormous quantity of prints.

To give an idea of the growth of the cotton industry in Russia, I may mention that, in the period 1866-79, the production of prints increased 167 per cent., while the number of works diminished 19 per cent., this increase, in production *pari passu* with the diminution in the number of manufactories being attributable to improved machinery; for, while in 1866, one workman produced 178·4 pieces of print, in 1879 he produced nearly 100 per cent. more. The spools spun in 1866 aggregated 1,895,500 puds (30,000 tons), in 1879 4,290,000 (70,000 tons). The calico woven in 1866 amounted to 3,972,000 pieces, and in 1879 to 14,821,000. In 1866, 3,384,000 pieces of calico were printed; in 1879, 9,050,000 pieces. In 1866, the number of hands engaged was 94,566; in 1879, this number had risen to 162,691. These figures will serve to show what great strides Russia

s making in this industry. Later returns are even more striking. The value of yarn spun rose from 42 millions of roubles in 1867, to 133 millions in 1888. With this increased production, the number of mills remained stationary, while there were fewer print works, proving that the industry was becoming more concentrated, the smaller establishments being absorbed by the greater.

During the last 10 or 15 years prices of cotton goods have declined, while the standard of quality has risen. The improvement in the art of dyeing is especially remarkable, particularly in reds—the popular colour—and it is stated in a recent work by M. Ruffalovitch, the well-known Odessa banker, that manufacturers like Baranof, Hübner, Zündell, the Tzareva Company, and Morozoff, are now able to produce the finer textures suitable for the markets of Central Asia and China, where Russian manufacturers are competing successfully with those of Manchester.

In forecasting the future of the Russian cotton industry, it may be worth remembering that, while dependent, to a large extent, on other countries — on America, for the raw cotton, on England, for machinery, on Mülhausen and Rouen, for designs, yet there are signs of the industry becoming nationalised. Central Asia supplies cotton, which, though inferior in staple, does very well to mix with American and other sorts; Russian mechanics are learning to make machinery, and, though this branch of the industry is still backward, the time will come when English mechanical skill will no longer be needed in Russia.

If we would see something thoroughly Russian we must visit the forest region of the north—the governments of Archangel, Olonetz and Vologhda, where the population is chiefly occupied in one form or another with the wood industry. Russia, says Mr. Atkinson, is, as far as her arts are concerned, in the period of wood. In winter, with his *topor* or hatchet, the peasant enters the forest, fells the giant pine, the larch, the birch tree or white fir, drags the fallen log with his little pony to the stacking-place, there to be stamped by the receiver. In spring he rafts the timber down the smaller stream to its confluence with the great river, then down this to the sawmill or seaport. Large numbers of the population find employment and earn a livelihood in this way. The subsequent operations of sawing the round logs into deals, or squaring them for building purposes, is another branch of the industry. The villages in Great Russia are all built of wood. Some of the churches are of the same material, the best to resist the extremes of cold and heat of the climate. There is little room for the display of decorative art in these log-cabins; occasionally, however, the traveller comes to a village where the façades are adorned with carved roof boards, and the window frames and shutters sometimes gaily painted. These have a picturesque appearance, reminding one a little of the Swiss châlet. On internal decorations and fittings the peasant of Great Russia devotes little labour or taste. He is too much concerned with the struggle for existence to have a mind for the beautiful in art. Quite different is the Little Russian. He adorns his *mazanka*, or clay-hut, outside and in with flowers, and tastefully embroidered linen cloths disposed on the walls; but the Cossacks of Little Russia are distinct in language, habits, and dress from the Great Russians, so much so, indeed, as to form with these two nationalities.

The industrial art of the peasantry is chiefly religious. Pictures of saints, called ikons, painted on wooden blocks or copper, are familiar objects, seen in every Russian dwelling, from palace to log-cabin. These paintings are mostly sombre representations of the Virgin, our Saviour, or some saint, often covered with plaques of silver, silver gilt, and even gold in some of the churches, leaving only the face, hands and feet exposed. A lighted lamp hangs before them on church festivals and saints' days. The preparation of the boards for these paintings is an industry of the government of Vladimir, the painting being done by hand in the monasteries. The method adopted is that of subdivision of labour: one set of monks paint the face, another put in the nose, a third the eyes, so that every feature is rendered in a particular style, which never varies. This is the height of conventionalism in art, and fully accounts for the absence of artistic merit in the ikon. The great sanctity attributed to some of these pictures is due to the miraculous legends surrounding them. For instance, over the sacred gate of the Kremlin at Moscow is a picture of the Redeemer of Smolensk, held in such high veneration that everyone passing under it uncovers his head. The image of St. Nicholas of Mojaisk, of our Lady of Kazan, and many others have all their legendary histories associated with some event in the life of the nation.

It would be interesting to follow up this subject, and trace the history of religious painting from the 11th and 12th centuries, when the monks of St. Athos produced a very similar type of sacred picture. Transferred to Russia, the art has remained almost unchanged, the stirring events in her history finding but faint echoes within the strong, fortress-like walls of the monasteries,

Mr. Morfill, the well-known author and reader in Slavonic languages at Oxford, classifies the different schools of ikon painting under the following heads:—(1) The Byzantine or Chersonian school; (2) the school of Moscow; (3) that of Novgorod; and (4) that of Strogonof. According to this authority, the first artists were of Greek origin, but they soon found Russian pupils. The models which had been received at Byzantium were faithfully adhered to at first, but gradually the art of ikonography acquired a different character in each part of the country. But M. Leroy-Beaulieu says that these schools were, strictly speaking, workshops, differing only in their treatment of the drapery and colours. The chief distinction I have noticed is that between the ikons of the old believers and those of the orthodox, the first having adopted a miniature style of painting, and eschewing all representations of Christ and the Virgin.

In recent times, however, a more artistic style of picture has been produced by the aid of chromo-lithography, and at the Troitsa monastery, near Moscow, and the Pechersky Lavra, near Kief, large numbers of these new ikons are sold to the pilgrims.

The industries of cabinet and furniture making have flourished in the governments of Perm, Nijni-Novgorod, Vladimir, Viatka, Tver and Moscow, the furniture of Viatka being celebrated for its cheapness. This is not, however, a very flourishing industry at the present time. The Russian peasant's requirements in the way of furniture are of the simplest; a table and some benches are all that is needed. The only thing he buys is the *sunduk*, or iron-bound wooden trunk, sold in large numbers at all the great fairs.

Of the smaller articles in wood, there is a very large production of spoons, knives, forks, and cups. The wooden spoon, Byzantine in shape, is indispensable in every household, for with this every peasant eats his food. These spoons are sent in large numbers to Central Asia, and with the samovar, or tea-urn, will in course of time help in civilising the nomadising Kirghiz, who now eat with their fingers. We should not omit to mention the important part that matting, made from the bark of the lime tree, takes in the domestic economy of the Russian people. Of this are manufactured the bags to contain flour, grain, &c., the heaviest and best being those used for flour. The bark of the young lime-tree is stripped to make into sandals, and of these some millions of pairs are required, involving the destruction of an almost incredible number of trees. It takes the bark of four saplings to make one pair of sandals, and it is estimated that ten millions of pairs are required annually. The trees are stripped in spring and summer, when they are full of sap.

The art of dressing leather is one in which Russia has excelled. "Russia leather," known as *yuft*, was an article of export in the 17th century, and efforts have been made to improve and develop this industry, but without any marked success. The tannery at Ostashkof, in the government of Tver, on Lake Seligher, at the source of the Volga, continues its old-fashioned methods, supplying the English market (it is curious that this leather should there be known as "English"), with nearly the whole of its production, notwithstanding the fact that the secret of its preparation has passed into other countries, and that Austria and Germany manufacture the famous leather at one-third of its cost in Russia. The final processes in its preparation are done in England, and these enhance its value tenfold, so that by the time it returns to Russia in the form of pocket-books, portfolios, book-bindings, &c., the Russian buyer has to pay dearly for his own leather.

In the same government of Tver is the town of Torjok, once noted for the beauty and picturesque dresses of its women, and for its gold and silver embroidery on leather, an art probably learned from the Tartars. The embroidery is all done by the women in winter, and is exposed for sale at the stations on the Nicholas Railway. Specimens of it were shown at the London exhibitions of 1851 and 1862, where they attracted no little attention.

It may be worth mentioning that Torjok is one of those places adversely affected by the introduction of railways. Not only has its famous leather industry declined, but the distinctive dialect, manners, and customs of the Novo-Torjians, as they are called, are things of the past. Its picturesque costumes are only to be found in books, and what is more serious, according to a modern Russian

writer, its rosy-cheeked, bright-eyed maidens have disappeared.

The iron industry ranks only second to that of textile fabrics in Russia. When I visited the mines and works of the Ural, some thirty years ago, Russia's iron trade was of no great importance. Prince Demidoff's and Monsieur Yakovleff's were then the only large works except those of the Government. At these charcoal iron of a high quality was rolled into rails or hammered into thin sheets for roofing. The growing scarcity of forests, felt even in those days, has limited the production, and the chief seat of the iron industry is being transferred to Southern or New Russia, where iron-mines and coal-fields have been discovered. But the Ural range is rich in copper, and the precious metals. Semi-precious stones, such as malachite, lapis-lazuli, aventurine, jasper, and porphyry are found there. These are cut and polished in the government works at Ekaterinburg, and adorn the halls and galleries of the Hermitage, and other public buildings at St. Petersburg. The objects consist of vases, tables, paper-weights, &c., and are attractive, not so much for any novelty or elegance in design they may have as for the rarity and beauty of the stones, as well as for immense labour expended upon them. The celebrated malachite doors, exhibited in London in 1851, are an instance of this stone-polishing art.

From recent statistics we learn that there were 522 iron mines in the Ural, in 1888, producing 49 millions of poods of metal; 20 mines in Southern Russia, with a production of 14 millions of poods; and 63 mines in Poland yielding 12 millions, total amounting to $87\frac{1}{2}$ millions of poods, or nearly $1\frac{1}{2}$ millions of tons of iron.

When I selected the subject of Russian industrial art for my paper before this Society, I had in view to say something of those village industries to which passing allusion has been made in the foregoing paper, and which I had seen in Little Russia, when I visited it in 1888. The so called *kustarny promysl* in olden times gave employment to many families, and was not confined to one branch of industry, or to any particular locality, but comprised textile, ceramic, and other industries, and was widespread throughout Russia. Large manufactories and capitalists have put an end to it, but there still survive, in a few out of the way towns or villages, some remnant of these bygone industries.

It was in one of these old-fashioned places that I happened to find myself. The particular village to which I refer is Oposhnia, in the government of Poltava, a great cereal-producing region, and interesting from its having once been the borderland of Russia. It was here that the Cossacks fought against Tartar, Pole, and Swede; this, too, was the country of Gogol, the great romance writer of Russia, and it was on these wide plains, now covered with waving corn, that Russia first learnt to become a nation.

The village of Oposhnia is a large one (according to old records it was a town as far back as the 12th century), and numbers 700 houses at the present day, inhabited by the descendants of those Cossacks who fought under their hetmans, Daroshenko and Briukovetsky. These Cossacks, long since become peaceful settlers, turned their talents to the ceramic art. They are celebrated, too, as horticulturists. Nowhere have I seen more beautiful irises than were growing at the time of my visit in the chief magistrate's garden. Possibly, the Oposhnians have imitated the colours of these flowers on their ware, for I noticed a remarkable iridescent lustre about their pottery which I have not seen elsewhere except in Spain. The clay they use is an excellent kaolin obtained in the neighbourhood; this is fashioned by hand into the common dish in universal use in Little Russia, and known there as the *miska*. The design is simple, but effective; only three colours are used, prepared from metallic oxides, and laid on the revolving plate in concentric rings, with the aid of a feather fixed into a horn handle; the ground is afterwards stippled in by hand with a brush.

Professor Zankévitch, who has made a study of this art, says that he found no pottery to equal it except in Switzerland. I found some like it near Seville, but, whatever its origin, the art is one well worth preserving. Besides the ordinary ware of everyday use, the Oposhnia potter occasionally indulges a flight of fancy, and produces some original design, which usually takes the form of a drinking-vessel or bottle to hold spirits. These are curious rather than artistic in shape, though showing ingenuity and skill in the manufacture.

From a few words of conversation with one of these handicraftsmen, I learned that times were not so good as they had been when the local consumption took all his produce. The middleman, that curse of the individual craftsman, had stepped in and undersold him in the

market, so that the industry was on the decline.

One more of the village industries of Little Russia must here be mentioned. This is the embroidered *plakhta*, or skirt of many colours, worn by the Little Russian women on holidays. A fashion for these had lately set in, owing to the Empress of Russia having hung one of the rooms of her palace with them. The shirt-fronts or *merejniki*, embroidered with Greek crosses in red thread, are another distinctive feature of the national dress. Shortly before my visit, some French travellers, passing through the country, were so captivated by these shirt-fronts, that they took specimens away to reproduce in the workshops of France.

A few more words on the future of Russian industrial art. We have seen how it has hitherto largely partaken of a religious character, jealously guarded and controlled by the priesthood and synodal authorities, how this art has become stereotyped or petrified through many centuries of imitation; how intercourse with the West has slightly modified the archaic type of ikonography, without, however, emancipating it from tradition. We have seen, too, how Western influences are pervading manufactures, and teaching Russia to make use of her immense material resources. Imbued with these Western feelings, a new school of art has sprung up. Sculpture, hitherto almost forbidden, is now taking a high position, and producing such works as those of Antokolsky, whose statue of Ivan the Terrible was exhibited some years ago in the Kensington galleries, and who has more recently modelled another historical subject, in the seated figure of Nestor, the annalist, of Lieberich and Lanceray, whose spirited groups of horses in bronze have been greatly admired. Among painters, too, there are already many known names, such as Vereschagin, the brilliant realistic artist of Central Asian life and landscape, Semiradsky, Makovsky, the brothers Sokoloff, and a score or two more.

Stimulated by the exhibitions, held at frequent intervals in St. Petersburg and Moscow, and by the Stroganoff school of design in the last named city, Russian art may have a future; but, whether inspired by the French or the Italian school, the subjects must be thoroughly Russian. They must depict in true colours native life and character, in every part of the vast and varied Empire.

DISCUSSION.

Mr. G. N. Hooper said he had made a few notes on Russia before coming to the meeting, but the paper was so comprehensive that it hardly left anything for him to say. He would, however, refer to one or two points which had struck him when visiting Russia in 1856. Any one who had visited the great palaces of Europe would have noticed the enormous vases of solid granite from Russia, which were extremely fine specimens of a manufacture in which it was necessary to overcome immense difficulties in dealing with such an intractable material. With regard to the more refined treatment of stone, veneering with malachite was brought to great perfection, but the charm of the work was to a great degree removed by the knowledge that it was only veneer. The enormous columns in the Isaac Cathedral would be entirely disfigured by a few blows from a hammer or hard substance. They were also very clever in dealing with what might be called semi-precious stones, which were worked up into various artistic objects. Then there was a school of artists in bronze who produced not only large but also small works, some fit for the decoration of large buildings, some small enough for the sideboard or mantelpiece. He should imagine that the liberality of the Russian Government in welcoming foreign artists in old times must have had something to do with it, but some of the Russian artists seemed to be very able men. He could support what had been said with regard to the Russian bells: the tone was very beautiful and melodious; one hardly ever heard bells elsewhere which could be compared with them. They were hung in open towers, so that the vibrations spread unchecked, and were heard over a very great distance. They also had very clever goldsmiths and silversmiths, and the *niello* work had a character of its own, which was very pleasing. Owing to the large army, the art of military equipment had been brought to a high state of perfection, and any one who had seen a Russian officer of the Imperial Guard in full uniform, and knew that it was all produced in the country, would acknowledge that they had considerable talent in that direction. The beautiful eagles which surmounted the helmets of the officers, and other ornaments, showed a high state of excellence in military uniforms. In addition to painting the ikons, Russian artists were making considerable progress, and acquiring a reputation beyond their own country. Some few years ago, some beautiful Russian landscapes were exhibited at a gallery in Pall Mall; and he was much struck with their excellence. The leather goods were very distinctive, and some of the embroidered leather slippers and other articles would, he thought, find a ready sale in this country. Probably few persons in this country understood how small some of the Russian cathedrals were; the one in which the late Emperor was crowned would at the utmost hold 500 people, so that when they read of the numerous cathedrals in the Kremlin at Moscow it

must not be imagined that they were like those of Western Europe—they were only the small cathedrals of the Greek Church. At the time he was in Moscow, in 1856, the cotton manufacture was being developed, and from what they had just heard, it seemed to be one of the most prosperous of Russian industries; and now that the steamers on the great Russian rivers were able to take large quantities of goods at a moderate price to distant parts of the empire, her merchants would, no doubt, compete severely with those of Manchester, in the markets of Northern Asia.

The Rev. R. PHILLIPS said there was hardly any mention of statuary in the paper, which probably arose from the fact that all art in Russia took its stamp from the prevailing ritual, and he understood that statues were forbidden in the Greek Church; he should like to know if that was correct. Everything concerning the civilisation of Russia was very interesting, it being such a backward country, which yet was struggling for more light, and making use of all the aid derived from the irruption of German, English, and French settlers, but still mainly striving to develop its own innate longings. The Slav mind had of late years developed very much in the direction of music, and to his mind that seemed to indicate a power of development in the future, which was very hopeful. There was a peculiar view of sadness running through both the art and literature of Russia, like the wail and anguish of a nation which had known much misery, and which found its natural expression in those sad strains. Russian literature was very striking, and though it was not all of it to be recommended, still it showed great genius. He should like to know what Mr. Morgan had to say as to the arts of printing and bookbinding in Russia.

Mr. HUGH STANNUS said the Society was much obliged to gentlemen like Mr. Morgan who came forward to give the result of their personal observation and experience. With regard to the remarks on Russian music, he knew many of their tunes, and had observed the melancholy which pervaded them, but it would be found that the music of isolated or mountainous peoples was generally in a minor key. The old Greek music had that character, and so had the Welsh. Many years ago he noted down the tunes sung by some Hindoos, as well as he could, for the intervals were very extraordinary, and some had no correlative in our diatonic scale; and the general character was decidedly that of the minor mode. With regard to pictorial art, many would remember the very fine exhibition by Vereschagin, some years ago, which formed an admirable object-lesson on the horrors of war; one picture, called "The Hospital Tent," might well have been reproduced in chromo-lithography—for no engraving would do justice to it—by the Peace Society, and distributed broadcast, especially amongst those who were mainly responsible for this great curse to humanity. The absence of beggars, or signs of extreme poverty in the great cities, though there was much misery in the country, was probably due to police regulations, as in Paris and many Continental cities, where all beggars were kept outside the barriers, so as not to shock the sensibilities of visitors. With regard to the Byzantine treatment of art in Russia, he would remark that M. Didron, in his book on Christian Ikonography, had mentioned the exceedingly conservative and unprogessive traditional character of Byzantine art, and gave copies of recipes for making pictures, preserved in the monastery on Mount Athos, which accounted for the extremely old character of the pictures. The fact was, they kept to the same type of Virgin as was seen in the Cimabue in the National Gallery, he being one of the earliest Italian painters before Italian art had emancipated itself from the old Byzantine fetters, and his work might well be taken for Byzantine. The Russian bowls were splendid examples of wood-work, and he was much interested in the decoration upon them. Reference had been made to the technical college founded by Peter the Great, which, he was sorry to hear, had been closed; but he had no doubt the Russians would find it to their interest to open it again. Whatever they did in the way of technical education, he hoped it would be confined to workmanship, and would not extend to design, for nothing grieved him more, when he went into a Russian court at an exhibition, expecting to see examples of real Russian art, than to find a number of imitations of French and German art, vases in malachite, copied from some Sèvres shape, or silver-work, imitating some vicious rococo form. Russians had an art of their own, and excellent materials, such as the semi-precious stones which had been mentioned, which were capable of very fine treatment, and he hoped they would do themselves justice, and not copy the miserable dregs of Western styles, which, in the time of Voltaire, had been introduced into Russia, not to its advantage. It was very interesting to see how certain industries were developed in particular localities. Those who had visited the corn plains of Tuscany would remember the admirable manner in which the straw was utilised in what used to be called Leghorn work, but was now called Tuscan. The city of Fiesole derived its income from the plaiting of this straw into beautifully artistic objects, which were purchased by visitors. He was interested to learn that straw-work was carried on in Russia, where there were hundreds of square miles of rolling wolds, whence corn was shipped, and there could not be corn without straw, so there was an opportunity for the people of that country to utilise the material that lay close to their hands. The most interesting industries of that country were those done at home, such as the wood-carving and embroidery of the Swiss, and the straw-plaiting of the Italian peasant. He was much struck by the fact mentioned, that the iron industry had gone from one part of the Ural mountains to

the other, because the forests were all burnt. That was just what had happened in Sussex and Kent, where the iron industry flourished many years ago, but it had now left the neighbourhood, because all the wood was destroyed. People were now hoping to find coal by deep boring in Kent, and if that were accomplished the iron industry would, no doubt, be resumed. He trusted that Russian applied art would grow and increase, and become more and more profitable; and, at the same time, that the Russians would develop their own national style, and not go to the Germans, and still less to the French, for any ornamental details. There were various elements in the Russian character, Byzantine, Sclavonic, and Mongolian, and all these combined together, made Russian art. In addition to those, there was a wretched French polish superadded in many cases, which he trusted would be got rid of.

Mr. C. M. Kennedy, C.B., thought that Mr. Morgan's paper was particularly valuable from his personal knowledge of the country, and ot the subjects to which it referred. The statement contained in the paper was very complete, and he had only one specific remark to offer. It seemed to him that Mr. Morgan had hardly explained with sufficient distinctness the present commercial policy of Russia. This policy, it should be remembered, was decidedly protectionist, and it had quite put aside the free trade tendencies which prevailed in Russia during the earlier years of this century.

Mr. Henry Deacon asked if there was any coal in the neighbourhood of Moscow. With regard to the question of free-trade policy, he feared that its influence upon the national taste in manufactures and art might be detrimental, and that Russia would be speedily supplied with wares from other European markets, which would ultimately lead to the same results which had to be deplored in India, the decay of native art. There was great reason to fear that Japan was suffering in the same way. The present policy of the Russian Government had, therefore, something to be said for it. He remembered, 30 years ago, seeing some splendid works in the Royal Academy by Russian artists, and it was evident that, as far as pure art was concerned, the Russian artist was going straight to nature. They were studies of forest scenery, simply in black and white, and he had never seen anything, before or since, at all approaching them in realistic power. With regard to typography, he might say that he had illustrated papers sent him from Russia, and they were printed with beautiful type on the finest paper, and the wood-engravings were of remarkable excellence. Residents in Russia, however, had to deplore extraordinary aberrations of taste as shown in the coloured decorations of architecture. The spires of churches would have a vermilion base with a beautiful emerald green spire on the top, and all kinds of barbarity of that sort. The Government did not appear to do much for the education of the peasants, which seemed to be the first step in developing home industries, for their condition was very lamentable in many parts of the country. There was a great deal to be done, and what was wanted was that the national art should be fostered, so that the world should not become more commonplace, as the result of commercial enterprise and travelling facilities.

The vote of thanks, on the motion of the Chairman, having been carried unanimously,

Mr. Morgan, in reply, said that the remarks of the several speakers showed a good knowledge of the subject, and proved that the English public were becoming better acquainted with Russia, and could find something to admire in the arts and industries of her people, however backward and incongruous these might seem from a West European standpoint. A question had been asked with reference to the Central Russian coal-fields, and he (Mr. Morgan) might be able to answer it from personal acquaintance. The coal measures of the Moscow basin, though underlying a vast area, and comparatively near the surface, were not of great importance, owing to the inferior quality of the coal. This had been compared with the brown coal of Germany, or lignite, and rapidly fell to pieces when exposed to the air. For household purposes, and to a limited extent for generating steam, it had been found useful, but it could not compare with English coal, or that of Southern Russia, with its seams of anthracite. The decline of the iron industry in the Ural, owing to the growing scarcity of charcoal, had been aptly compared to a similar state of things in England about two centuries ago. To this day traces of old blast furnaces could be seen in Kent and Sussex where ironstone was smelted with charcoal. The discovery of coal in the North and West of England completely changed the iron industry in our country, just as the discovery within the last quarter of a century of coal and iron in the government of Ekaterinoslaf had opened a great future to that of Russia, and promised a new source of wealth when, owing to the destruction of forests, the rich iron ore of the Ural districts could no longer be profitably worked. With regard to protective tariffs, the present condition of Russian manufactures would not allow of these being discontinued for the present. The time might come when foreign competition would not be feared, but the Russian mechanic had much to learn before so desirable a policy as that of free-trade could be introduced. Russian artisans were, as a rule, drawn from peasantry class, and only remained part of the year in the manufactories. At seed-time and harvest they usually returned to their homes, and engaged in husbandry. In some respects, therefore, their lives were more cheerful than those of the English manufacturing population. Schools of art

had been established in Russia, and that, founded by Count Stroganoff, in Moscow, had done its best to preserve national art, and apply this in the various industries and handicrafts; but the Government might do a great deal more than it did to foster and direct national taste. In their technical schools they strove to follow the model of the Science and Art Department in South Kensington, and he (Mr. Morgan) thought it might be an excellent thing if the English Government could see its way to afford facilities to Russian art students to receive their education in this country. The use of bright colours for external decoration had been criticised, but he thought that, however contrary to the strict rules of art, there might be some excuse for bright reds, blues, and greens in a country like Russia, where the greater part of the year the ground was covered with snow, and the prevailing tints of the landscape were white and grey. It was a relief to turn from such monotonous surroundings to red and blue walls and green roofs, and the clear atmosphere and sky in those northern latitudes heightened the pleasing contrast.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 17, 1893; Captain W. DE W. ABNEY, C.B., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Hale, William Carlton, Ivy-hall, Wrotham, near Sevenoaks, Kent.

Lineham, Professor Wilfrid James Jesmond, Leyland-road, Lee, S.E.

Reuter, Baron George de, M.A., LL.B., 18, Kensington Palace-gardens, W.

The following candidates were balloted for and duly elected members of the Society:—

Perceval, Westby Brook, 13, Victoria-street, S.W.

Prater, Thomas Herbert, Parlington Estate-office, Aberford, near Leeds.

The paper read was—

COMPOSITE HELIOCHROMY.

A Second Paper on Photography in the Colours of Nature.

By F. E. IVES.

The heliochromoscope was first publicly exhibited one year ago, in London, before the Royal Society, the Royal Institution, and the Society of Arts, in connection with demonstrations of the process of composite heliochromy upon which I have been working for several years. As was explained in my paper of May 25th, published in the *Journal of the Society of Arts* of May 27th, 1892, the heliochromoscope and its triple photograph, or chromogram, are calculated to reproduce the colours of nature as readily as the stereoscope and stereogram reproduce binocular perspective.

The photographic process by which the colours of nature are reproduced was perfected in theory nearly five years ago, and its capabilities were demonstrated at a meeting of the Franklin Institute, in Philadelphia, in November, 1888. In order, however, to operate the process advantageously, it was necessary not only to provide a special optical lantern for superposing on the screen the three images of the chromogram, but also a special camera which would enable the triple negative to be made by the exposure and development of a single sensitive plate, as in ordinary photography. I designed such a camera in 1891, and by means of the heliochromoscope, a modification of the camera, by which the three images are blended without either lantern or screen, I reduced the method almost to the simplicity of stereoscopic photography.

Owing, however, to certain inherent defects in the photographic negative making process, which have long been known to affect the rendering of gradations in monochrome photography, and, therefore, must also affect the colour-rendering, I have since given much study to realising the most favourable conditions for reducing such defects to a minimum, and to defining the nature and extent of the limitations which they impose. Much experiment has also been devoted to overcoming other difficulties which I shall mention, and, although a truly astonishing illusion of nature is realised in the heliochromoscope, I estimate that it may take another year to carry out all the experiments and make all the measurements necessary to enable me to finally demonstrate the capabilities and accurately state the limitations of the process, and to publish complete and satisfactory instructions for operating it.

Meanwhile, having been called to London on business of another kind, the Council of the Society of Arts honoured me with an invitation to "report progress."

As was fully explained in my paper of last year, my own process of composite heliochromy consists, first, in the production of a triple photograph, to represent the effect of light from the object upon the three separate fundamental colour-sensations, in accordance with the Young-Helmholtz-Maxwell theory of colour-

vision; and, second, in the blending of the three images into one, either optically, by means of the triple lantern or the heliochromoscope, or otherwise, by the superposition of three transparent colour-prints. Although the three fundamental colour sensations are red, green, and blue-violet, the three images of the triple photograph are not made through red, green, and blue-violet glasses, nor by the action of red, green, and blue-violet rays, but each by the joint action of all rays that have power to excite the respective fundamental colour sensation. Not only do the red rays, but the orange, yellow, and yellow-green rays also excite the fundamental red sensation; the orange rays affect it even more powerfully than the pure red. The photograph, to represent the effect upon the red sensation, is, therefore, made by the action of all these rays, and in due proportion, in accordance with Maxwell's measurement. The photographs of the green and blue-violet sensations are also made by the joint action of rays of various colours, in proportion to their power to excite the respective fundamental sensations, according to the measurements of Maxwell and Abney. But, when the images of the triple photograph are blended into one, by means of the triple lantern or the heliochromoscope, the photograph of the red sensation is illuminated by red light only, the photograph of the green sensation by green light only, and the photograph of the blue-violet sensation by blue-violet only. In other words, the three images of the chromogram represent the action of all incident light upon the respective fundamental colour sensations, and the light by which each image is illuminated in the lantern or heliochromoscope represents the sensation itself. The result of blending into one the three images of the chromogram—each being illuminated by the kind of light intended for it—is a faithful reproduction of the object photographed, in all its subtleties of light, and shade, and colouring.

Last year, my projections on the screen were made with the lime-light, the performance of which was very unsatisfactory to me, in comparison with sunlight projection, which I had employed at my house in Philadelphia. Now I am provided with a lantern adapted for electric light, and will repeat my demonstration with it, before proceeding to describe the colour-camera and heliochromoscope. In this lantern a single arc electric light is the source of illumination. After being collected by a condenser system in the usual manner, the light from the arc is sub-divided into three portions by means of a system of mirrors, some of which are transparent, so as to both reflect and transmit light, substantially as in the heliochromoscope-camera, which I shall describe later on. In the path of each divided beam of light is placed a smaller condenser and a colour screen; in front of these a chromogram; and then the objectives by which the images are projected and superposed. This device differs from all others that have been proposed for the purpose, in that the disc of light on the screen remains white when the electric arc varies its crater. The systems formerly proposed for use with a single light would be quite useless under such conditions.

I commence by demonstrating the production of white light by mixing the red, green, and blue-violet rays. In the heliochromoscope the intemediate rays—the yellow and blue-green—are entirely suppressed, only comparatively narrow bands of red, green, and blue-violet showing, if a spectroscope is applied to the eye-piece. The colours that I am now using in the lantern are not quite so pure; the spectroscope shows broader bands of colour, but they are still separated from each other by darker bands in the yellow and blue-green parts of the spectrum. With these screens the illumination is sufficient for projections of moderately large size, and the colours are pure enough to demonstrate the fact that the red and green light mix to produce yellow, and that the addition of blue to the yellow makes, not green but white. The insertion of one of the chromograms shows that the infinite variety of the colours of nature can be obtained by the intermixture of the three colours, red, green, and blue-violet in various proportions.

Scientists have known these facts about the mixture of coloured lights for a long time, but I take advantage of every opportunity to repeat the demonstration, because many people still doubt the facts.

I must also take this opportunity to again emphasise that it would be quite impossible to obtain any such result as that now shown with any system employing the same colour-screens both for photography and for projection, as was advocated by all other writers upon this subject previous to my publications in 1888. The science of composite heliochromy cannot be understood without knowledge of this fact, which I have repeatedly pointed out and explained, but which certain

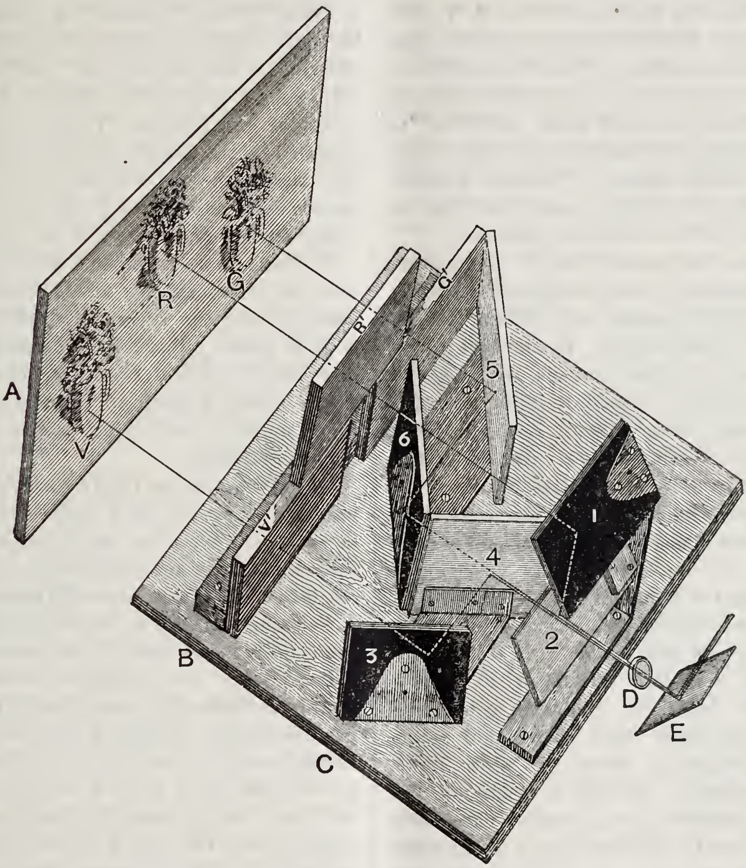
well-known writers have, nevertheless, persistently ignored.

The subjects that will now be projected upon the screen will illustrate the capabilities of this system of colour-photography, as adapted to lecture illustration, better than was possible with the lime-light lantern used here last year.

The illusion of nature will be found even better in the heliochromoscope than on the screen, because the colours are purer, and the illumination is better.

The method of superposing three images upon a screen, by means of three separate objectives, is sufficiently known, and need not be described in this paper. The system employed in the heliochromoscope is not only a very different one, but, I believe, quite different from anything else that has ever been suggested. I shall try to make it clear by reference to a diagram, showing the construction of the perfected instrument.

A is the chromogram, B, C a removable base-board, carrying the colour screens B, and the



mirror system C. D is an achromatic objective lens, and E a silver mirror.

Light transmitted by the image of the red sensation, R, passes through the red colour screen, R′, to the silver mirror, 1, downwards to the transparent mirror, 2, and forwards (except the portion which passes through the transparent mirror and is lost), through the objective, D, to the inclined mirror, E, and upwards into the eye-piece, under which a reduced image is formed by the objective, D.

Light transmitted by the image of the blue-violet sensation, V, passes through the blue-violet colour screen, V′, to the silver mirror, 3, sideways to the transparent mirror, 4, forwards through the transparent mirror, 2, and objective, D, to the inclined mirror, E, and upwards into the eye-piece, under which a blue-violet image is formed, exactly coincident with the red image. That portion of the light which passes through the transparent mirror, 4, is lost, and also that which

is reflected downwards by the transparent mirror, 2.

Light transmitted by the image of the green sensation, G, passes through the green-colour screen, G′, to the silver mirror, 5, thence sideways to the silver mirror, 6, forwards through the transparent mirrors, 4 and 2, and the objective, D, to the inclined mirror, E, and upwards into the eye-piece, under which a green image is formed, exactly coincident with the red and blue-violet images. A portion of the green light is lost by reflection from the transparent mirrors, 4 and 2.

The fact that the light-rays, from R, V, and G, travel equal distances before entering the eye, and have a common axis after emerging from the mirror system, secures a direct blending of the images, which must otherwise be projected upon a matt surface in order to be seen as a single image. Prismatic devices, as proposed by Du Hauron, and others, fail in this respect, and are, therefore, useless.

An optician will readily see, in the instrument as described, various apparent defects, none of which, however, are evident in the instrument as constructed. In the first place, in the absence of colour-screens, the image of the green sensation, formed of light reflected from a central silver mirror, is much more brilliant than the other images, formed of the weaker portions of light reflected from the central transparent mirrors, which are unsilvered, plane-polished glasses. But the band of pure green light in the spectrum is very much narrower than the bands of red and blue-violet, and this apparent defect is, therefore, in reality, an advantage, because it permits of the use of a screen that transmits the light of only a very narrow band of spectrum green, instead of the broader band that would otherwise be necessary to make up white light. Another apparent defect is that, if the transparent mirrors have parallel plane surfaces, they will, if clear, give a doubled instead of a single image. This defect can be removed, by making the mirror 4 of canary-yellow glass, which transmits both red and green light freely, but destroys all the blue-violet light that is not reflected from its first surface; and the mirror 2 of a cyan-blue glass, which freely transmits both green and blue-violet light, but destroys all red light that is not reflected from its first surface. This method of correction is objectionable, because it reduces the intensity of illumination by nearly one-half. The method that I have adopted is to use thin glasses, having the two plane surfaces inclined to each other just sufficiently to make the two reflected rays coincident at D. Another apparent defect is found in the fact, that the amount of light reflected from the plane glasses used as transparent mirrors varies with the angle of incidence. With the arrangement shown in the diagram, the top of the image of the red sensation will appear brighter than the bottom, and the outside of the image of the blue-violet sensation brighter than the inside. The disk of light seen in the heliochromoscope —when the chromogram is absent and the instrument directed towards a white sky—will be white only in the centre, the outer portions showing a delicate tint of blue on the one side, yellow on the other, pink at the top, and green at the bottom. This defect has been removed by the simple expedient of inclining the colour screens, so that the stronger ray passes diagonally through the coloured glass and the weaker ray straight through.

The mirrors are attached to brass supports, and are adjustable by small screws pressing them against the springs by which they are held in place. But the adjustment is such a nice matter that a twentieth of a turn of a single screw, having 56 threads to the inch, would make the instrument useless until it had been re-adjusted.

One of the cameras I use for making the chromogram negatives is a converted heliochromoscope, the eye-piece serving as an objective, projecting an image that includes nearly 50° angle of view. It may be readily reconverted into a heliochromoscope by substituting a chromogram holder and *pure* colour screens for the plate holder and *selective* colour screens. In this instrument, transparent axial mirrors are used for the images of the green and blue-violet sensations, and a pair of silvered mirrors for the image of the red sensation, because the latter image must be made many times brighter than the others on the sensitive plate employed. This is a more compact and convenient form of camera than any other that I have devised for this purpose, but the aperture of the eye-piece is so small that it is necessary to give very long exposures—up to ten minutes on well-lighted landscapes with ordinary isochromatic plates.

When circumstances do not admit of the longer exposure, I use another form of camera, in which the mirror system is arranged in front of three separate objectives. This camera, in comparison with the compact inverted heliochromoscope, is somewhat clumsy, and in-

cludes a smaller angle of view, but has an effective aperture of about f.16 for the image of the red sensation, and requires not more than 30 seconds exposure for objects illuminated with clear sunlight.

I now come to the consideration of the defects of the system as a means for reproducing the colours of nature. One of the greatest photographic authorities has said that no method depending upon the production of photographic negatives by known processes can possibly be made to secure accurate reproductions of colour, because no known photographic negative-making process will accurately reproduce monochrome light and shade. This statement is strictly true, and the fact must not be ignored, even though the defect referred to affects the success and value of colour photography scarcely more than it does the success and value of monochrome photography, which can be made to give reproductions of the majority of monochrome subjects, good enough to be generally accepted as true *fac-similes.*

In monochrome photography, the contrasts in the middle shades of a correctly exposed negative are always more or less exaggerated, at the expense of both ends of the scale. The positive print from such a negative will, upon critical comparison with the original, appear more or less weakened or bleached in the lighter shades, and heavy in the shadows, with undue contrasts in the middle shades, especially if the original shows strong contrasts of illumination. In composite heliochromy, the same defect must evidently be present, making colours appear as if slightly faded in the lighter shades, and dull in the deeper shadows, with undue strength and contrast in the middle shades. This defect is seldom noticeable in reproductions of evenly-illuminated objects, when photographed upon the highly sensitive and soft-working photographic plates available for this work. The defect, however, may be offensively evident in reproductions of objects showing strong contrasts of illumination.

Another consequence of the same defect in the photographic negative-making process is undue intensification of the stronger elements of mixed colours in the deeper shades of the picture. For example, an orange which is a mixture of four parts of red to one of green (physiologically), if it act with exactly four times the force in producing the negative of the red sensation that it does in producing the negative of the green, will be represented by more than four times the density of deposit, in case only a moderate exposure be given (because the density is always disproportionately great in the middle shades of the negative), and will, therefore, be reproduced as a slightly redder orange than it really is. A full exposure corrects this defect, and an excessive exposure, by bringing the green element into the middle shades of its negative, and the red element into the high lights of its negative, either reverses the defect, making the orange too yellow, or in case it is originally impure (*i.e.*, mixed with a small proportion of white light), may even produce a suggestion of brick-red in the reproduction.

This defect is not as serious as might be expected, because it is really only an exaggeration of effects produced upon the eye in ordinary vision, by corresponding variations in the illumination of the object, for which the judgment, from mere force of habit, instinctively makes allowance. In this connection, I quote from Rood as follows :—

"Coloured surfaces undergo changes of tint when they are seen under a very bright or a very feeble illumination. . . . . The violet of the spectrum is easily affected; when it is feeble, that is, dark, it approaches purple in its hue; as it is made stronger, the colour changes to blue, and, finally, to a whitish grey, with a faint tint of violet-blue. The changes with the ultramarine blue of the spectrum follow the same order, passing, first, into sky-blue, and, finally, into white. Green, as it is made brighter, passes into yellowish-green, and then into whitish yellow; for actual conversion into white, it is necessary that the illumination should be dazzling. Red resists these changes more than the other colours, but, if it be made quite bright, it passes into orange, and then into bright yellow. . . . . Colour sensations, which are due to the joint action of two sets of nerves, speedily diminish when the colour is darkened, and are replaced by the primary sensations—red, green, or violet. The sensation of orange is produced by those light waves in the spectrum which have a length such as to enable them to stimulate the red nerves strongly, and the green nerves to a lesser degree; hence, when orange-coloured light is made very weak, it fails to act on the green nerves, while feebly stimulating the red. For similar reasons, the sensations of yellow and greenish-yellow pass into green, as do also those of greenish-blue and cyan-blue; in the same way, the sensations of blue, ultramarine blue, and violet-blue pass into violet."

In short, we have in this colour photography imperfect rendering of the relative intensities of colour in the different shades of the picture, corresponding to the imperfect rendering of

gradations in monochrome photography, and also exaggerations of the visual effect of varying intensities of illumination upon colours, due to the same defect in the negative process.

I will take this opportunity to suggest that the similarity of the photographic defect to an inherent defect of colour vision may be taken as an argument in favour of the theory that colour vision is itself essentially photographic. It appears to me that there may be in the retina three light-sensitive chemical substances, each of which, when acted upon by light, reacts upon the nerves of vision to produce a definite sensation, which is one of the recognised fundamentals. We may assume that one of these substances resembles, in its optical properties, a coal-tar dye, which is sold as "multiple yellow," and which shows an absorption curve very much like Captain Abney's curve to represent the action of spectrum rays upon the fundamental blue-violet sensation; that another substance similarly resembles aniline majenta, which shows an absorption curve similar to Maxwell's curve for the action of spectrum rays upon the fundamental green sensation; and that a third similarly resembles an aniline blue, that shows an absorption curve similar to Maxwell's curve for the action of spectrum rays upon the fundamental red sensation. Such substances may be in liquid form, like solutions of the dyes, and the mixture, like a mixture of the dyes, would absorb all the spectrum rays that excite vision. The spectrum rays at Fraunhofer line D would be absorbed about equally by the blue and majenta substances, thereby exciting about equally the two fundamental sensations red and green, which make up the compound sensation of yellow. All other compound sensations would be similarly explained. Solarisation in one of these substances, by bleaching or destroying some of it, would temporarily weaken the corresponding sensation, but, at the same time, increase the sensitiveness of that portion of the retina to other colours by giving some of the spectrum rays freer access to one or both of the other two substances. It seems to me that no other theory will explain so much as this. But my paper is not on the subject of colour-vision, and I must, therefore, reserve further consideration of this subject for another occasion.

Under favourable conditions, the photographic defects which I have mentioned are so small as to pass unnoticed by the ordinary observer, to whom the reproduction seems perfection in every respect; under unfavourable conditions, the results might be quite as unsatisfactory as are sometimes the results in monochrome photography. To look for a nearer approach to perfection would be unreasonable in the present state of photographic science.

I hope to go more exhaustively into this branch of the subject at some future time, but believe that, in a general way, I may claim to have stated the case fairly. If the scientific specialist is inclined to think that I may have made out too good a case for composite heliochromy, the practical photographer will, on other hand, be astonished to find that, in spite of all theoretical and practical difficulties, the image of familiar objects as seen in the heliochromoscope, is as satisfying to the eye as the transient image on the ground glass of the camera, which he has so often admired and dreamed of fixing.

In actual practice, defects due to quite different causes have been far more troublesome and irritating to me than either of those described. Fortunately, however, they are not inherent in the process, and it was only necessary to discover their true cause in order to eliminate them. With certain developers,—hydroquinone being one,—the image of the blue-violet sensation commences to develop first, and goes on almost to completion long before the detail is all out in the image of the red sensation, even though the latter may appear relatively over-exposed after the development is fully carried out. Under such circumstances, the relation between the two images will vary with the time the plate is left in the developer, and it is difficult to insure accuracy. This difficulty was substantially overcome by using the eikonogen developer, and seems to have entirely disappeared with rodinal development.

With some sensitive plates, the image of the green sensation, formed principally in eoside of silver, developes more density than either of the other images, and introduces troublesome irregularities. Fortunately, some of the best makes of sensitive plates are free from this defect, and may be selected for this purpose.

For a long time, in spite of every precaution I knew how to take, my negatives developed considerable more density towards the edges of the plate than towards the middle. The consequence of this was that the top of the negative of the red sensation, and the bottom and outer sides of the negatives of the green and blue-violet sensations, would be so overdense as to make the colours in those parts of the re-

production distinctly incorrect. I imagined this to be due to a defect in the sensitive plates, an effect of the more rapid drying of the emulsion at the edges in process of manufacture. In this I was, happily, mistaken. It proved to be due to access of air to the outer portions of the plate during the process of development, by constant rocking in a dish containing a rather small quantity of developer. The unevenness disappeared as if by magic when the plates were developed by deep immersion in the developer in a dipping bath. Probably the reason that this unequal action of the developer has not been noticed in monochrome photography is that the centre of the plate usually receives more light than the edges, and the action which is so injurious in the colour process is seldom more than sufficient to compensate for this unevenness of illumination.

In my earlier experiments, light objects against a dark ground frequently reproduced with a red or reddish halo, because of strong halation in the image of the red sensation, so that, even for objects that come very well in monochrome photography, I found that the plates should be "backed" for composite heliochromy.

The results which I show, taken in connection with what I have said, will make it evident that the process has already been reduced to very successful practical operation in my hands, and that the conditions of success are such as may easily be realised by others when provided with the same apparatus properly adjusted.

The method of carrying out the process to the production of colour-prints, although it will doubtless prove of great value for some purposes, cannot, by reason of its complications, difficulties, and cost, be successfully utilised by amateur and general photographers. As long ago as in the year 1881, when I was the only successful producer of half-tone process blocks for the type press, and had considerably improved upon the older methods of composite heliochromy, without quite realising the true principle which I first published in 1888, I made the first photographic reproduction of a coloured subject by three impressions from process blocks. This three-colour print, a reproduction of a chromo-lithograph, was referred to in a leading article in the *Photographic News* of Sept. 5, 1884, p. 561. I have one of the prints with me now. The lines expressing the light and shade were run in different directions in the different blocks, in order to avoid the production of a disagreeable pattern — a plan which has quite recently been claimed and patented as a new invention in Germany, and adopted by Kurtz, of New York, and others. My Franklin Institute lectures upon this subject, in 1890 and 1891, were also illustrated with examples in cemented gelatine colour-prints, mounted as lantern-slides and window transparencies. The latter are now in the United States National Museum at Washington. I have not followed up these developments of the process very industriously, because it has been my ambition to realise a simple and readily available method of photographic colour reproduction, perfect so far as it goes, before undertaking to fully develop the process in its more complicated form. The best fruit of my efforts in this direction is the heliochromoscope and its appurtenances, which I claim to be the first completely successful means for reproducing the natural colours by photography.

I believe that scientists who have been aware of the impossibility of escaping from the inherent photographic defects which I have described, have greatly overestimated their importance, through quite overlooking the fact that they result in nothing more serious than an apparent exaggeration of natural defects of colour-vision, for which we are already in the habit of making unconscious allowance.

While the not altogether unreasonable doubts of the true scientist have made him cautious and reticent in his attitude towards the claims made for composite heliochromy, some, who write with an air of authority upon subjects quite beyond their comprehension, have industriously discredited my efforts to substitute the application of true theories, definite methods, and scientific tests for false theories, wrong and indefinite methods, and unsuccessful guesswork. A well-known representative of the latter class recently went so far as to characterise my work as a mere "laying of stress upon words," "of the nature of throwing dust into the eyes of simple mortals." This is certainly a sufficiently bold and simple way of combating facts and arguments that are not comprehended. A sufficient reply to all such wilful or accidental misrepresentations, past or future, may be found, by those who are capable of understanding the subject, in the two papers which I have now had the honour to read before the Society of Arts, and in the references given and results shown.

Objection has been made to the use of the terms "heliochromy," "photochromy," and "colour photography," as applied to this process of colour reproduction. It has been said that because colours can be produced directly by the action of light upon certain sensitive surfaces, these terms should be restricted to processes of that character. It was to meet this objection that I named the process "composite heliochromy." If a better descriptive name can be suggested, I will readily adopt it. But I shall be greatly surprised if the public does not finally insist upon calling the production of chromograms after my method by the name of "colour photography," just as they now call the production of stereograms "stereoscopic photography." It is of comparatively little consequence what name is given to the direct processes, so long as they cannot be made to reproduce the colours of nature, and are, therefore, of no interest to the general public. It is the successful process that should have first choice of suitable names. The only recognised talking machine of to-day is the phonograph, although the name "talking machine" was applied to something far different—an arrangement of bellows and reeds, and pipes, and keys, in imitation of the human vocal apparatus—long before the phonograph was dreamed of. Perhaps the heliochromoscope would be more properly called a photochromoscope, a name which I like better, but have not adopted, because inventors of devices of a very different character have already been quarrelling about the right to use it.

In conclusion, a criticism of the heliochromoscope, from the painter's point of view, may be of interest. An artist friend, who leans toward the Impressionist school, on seeing the instrument for the first time, said the reproductions of nature offended him in the same way that ordinary photographs did, by idealising nothing, and leaving nothing to the imagination; in short, the reproduction was "too absolute to be artistic."

DISCUSSION.

Mr. J. WILSON SWAN congratulated Mr. Ives on the marked progress he had made since he last showed his results in that room. He had told them plainly the limits of his ambition, that of attaining a practical method of producing what he thought was attainable in the direction of colour photography. Popularly, no doubt, photography in natural colours meant something different from what had been shown that evening; it meant a process by which not only light and shade, and the natural forms, but also the colours of the objects, would be produced directly on the sensitive surface. Some sanguine people conceived that such a thing was not impossible, but many far-seeing and able men considered it to be quite unattainable, and these would certainly not be the discoverers. The path of progress and discovery was illuminated by the light of hope, and to search for any object hopelessly was not the way to find it. He believed that the feeling that colour photography was unattainable had restricted experiment, and, as without experiment very little progress could be made, it was not wonderful that colour photography, in this ideal sense, had not yet been realised. Within the last few days particulars had appeared in the newspapers, to the effect that the long-desired result had been achieved in Paris, and that some few had been privileged to see it. He at once felt a strong impulse to go off to Paris and satisfy himself, but checked the impulse with the reflection that if this piece of news was true—as it was well-known how deep an interest the President of the Photographic Society of Great Britain took in the subject, and as Paris was only about eight hours distant from London—it was almost certain that some examples of the alleged discovery would have been there that night. Since they were not, he feared that one more disappointment was going to crush this hope. In short, this discovery had been announced about as often as that of the "sea serpent;" and, probably, the chances of such reports turning out to be true were nearly equal. It struck him that the form of colour photography which had been described that evening had one advantage even over the more ideal process to which he had referred, viz., that it contained within itself the elements of multiplication and reproduction by means of negatives, a feature that characterised the photographic method originated by Fox Talbot, a most valuable feature, and one which he thought was hardly appreciated at its true value. He hoped that this would not be the last time they would see Mr. Ives at the Society of Arts. What had been shown and described that evening was, without doubt, the high-water-mark of what had, so far, been obtained in colour photography; and one hardly knew which to admire the most, the logical clearness of Mr. Ives's ideas and the expression of them, the ingenuity of his devices, or the beauty of his results.

Lieut.-Col. ALLAN J. C. CUNNINGHAM, R.E., said that Mr. Ives spoke of the chromogram as containing three images, which he called the red, green, and blue; but, if he understood rightly, those were only the names of the colours they saw on the screen, which were carried by the light passing through the coloured glasses. He should like to know if that was so, and also if three images were taken at once by the same process, with the same chemicals, on one film, and what was the nature of that film.

Mr. FRANCIS COBB also congratulated Mr. Ives on the progress he had shown. Mr. Swan evidently

was in hopes that something would yet come of colour photography; but he (Mr. Cobb) could not help expressing his surprise that a man so familiar with nitrate of silver and its compounds should expect to get much more than a brown result from it. The Fox-Talbot process and the multiplication of prints seemed to him very much on the same line that Mr. Ives was now travelling, except that the latter dealt with the colours in the first instance, whilst the Fox-Talbot process in the coloured specimens he had seen used pigments. In the present case, the colour was brought out by superposing one picture or the other.

Mr. CHAPMAN JONES said that no one could fail to be gratified at the result Mr. Ives had attained. Until the last few sentences he was congratulating himself that Mr. Ives had dropped the terms colour photography, and photographing in natural colours, and rather regretted that he had revived them. He would suggest that until these terms were proved to have no real fact to correspond with them, or that the thing was actually accomplished, it would be better, for the sake of clearness, not to use them in connection with this process.

Mr. E. J. WALL asked whether the slight defect in colour noticeable at the edges of one of the photographs was due to anything in the negative, or was there any defect in the process which he understood had been suggested could only be got over by the use of a fourth negative, and the printing in of a monochrome first?

Mr. L. M. BIDEN asked if one of the negatives could be shown on the screen without the interposition of the coloured light. He presumed the three negatives had different densities in different parts, and the part which caught one colour would not be the same as the part which caught another, or were the three identical except in chemical composition.

The CHAIRMAN suggested that it would be interesting if Mr. Ives could show the colours of the colour-screen which he used in his camera, and also the colours he used to project the pictures on the screen.

Mr. IVES said the images which formed the chromogram had no colour themselves; they were only a register of colours, and might be compared to the wax cylinder in a phonograph, which contained no sounds, though it registered them, and, on putting the instrument in operation, reproduced them. In the triple photograph there was a record of the colours, and when it was put into the heliochromoscope, they were brought back to the eye. One image was called the red, not because it was red, which it was not, but because it represented the relative amount of action on the fundamental red sensation. It represented the effect of light coming from the object upon the fundamental red sensation. The same with the blue and the green. He had not attempted to go into the science of the subject that evening, because he did so very carefully last year, when he explained what various colours of the spectrum excited each fundamental sensation. The sensation itself was of a perfectly simple colour. The screen to produce the effect of the red sensation in the negative must transmit sufficient not only of the red, but of the orange-yellow, and yellow-green rays, all of which had the power to excite that sensation. The exact colour of the screens in the camera depended on the colour sensitiveness of the photographic plate. If the latter were twice as sensitive to red as to orange, while, on the other hand, the fundamental red sensation was affected twice as much by the orange rays as by the red, it would evidently be necessary to use a screen which cut out some of the red rays, which would otherwise have a disproportionately strong effect. The plates actually used were many times more sensitive to orange than to red, and it was necessary in practice, in order that the red rays should have time to do their share of the work, that the colour screen should cut off a very large proportion of the orange rays. The screens were tested by photographing the solar spectrum, and it was assumed that they were right when the photograph of the spectrum showed a distribution of density which corresponded to a curve representing the power of the different rays to excite the respective fundamental sensations. The heliochromoscope and lantern screens, on the other hand, were, like the fundamental sensations themselves, of pure simple colours. The subject was very difficult to follow for any one who had not made a special study of it. As he had stated in the paper, he had devised a camera with which the triple photograph could be made at one exposure of one sensitive plate. He had also explained that the tint of yellow-green on the edge of the water pitcher was due to a defect in the development, not to anything inherent in the process itself.

The CHAIRMAN said he believed he was one of the first to see the results of Mr. Ives's work, last year, and he must say that what he had now brought forward showed a very decided advance, and was not only very interesting, but of scientific value. One could not help seeing that Mr. Ives had worked on thoroughly scientific principles. It was not every one who would undertake to find out what the three fundamental colour sensations were, and where they were situated in the spectrum. A good many who had worked in this direction had not taken so much trouble, and some had selected colours which did not really excite the fundamental sensations. The three which Mr. Ives had chosen seemed to be very near the truth, as far as was at present known. The red sensation was stimulated by the red which lay near the limit of the solar spectrum, and when you got as far as the C line, where the red was pretty bright, there was a very small contamination of green with it; but so small that you might use it, without serious error, for over 90 per cent. of the colour sensation produced in

the eye would be caused by the stimulation of the red-perceiving apparatus. The green was situated not in the yellow-green, but was a distinct green of itself; probably only one man in twenty-five had ever felt the true fundamental green sensation at all, because they must be colour-blind in order to do so; the real fundamental sensation was so much mixed up with white, that we only felt the green largely diluted. The blue-violet was the one at the far end of the spectrum, somewhere about G, and was very fairly represented by the colour Mr. Ives had chosen. He was rather glad Mr. Swan had not gone to go to Paris to see the colour photographs which were reported, for had he done so, he would not have been present to have made his remarks. From the accounts he (Capt. Abney) had received he was very sceptical whether any real progress had been made in colour photography. What the Paris process did was to show interference colours. That was not true colour photography, and would only be achieved when actual pigments were produced. A photograph in which the same part looked red in one light and green in another was not colour photography. There were several very interesting points in the paper with regard to the modes of developing; for instance, the fact that the image exposed to the red would not develop with hydroquinone as rapidly as blue did. This he had long been familiar with, and there was a scientific explanation of it which ought to be known, but which would take too long to detail now. Again, he had always held that, in some sensitive plates, the image formed by the green rays was principally formed in the eoside of silver; it had often been combated, but he still held to it, and was glad to find that Mr. Ives's experience confirmed him. Another interesting fact was the method of applying the developer. Mr. Ives said that he first thought the fact that the plate developed more in density at one part than another was due to its not being evenly coated; but directly he prevented the access of air to the outer portion during the process, the mischief vanished. That might teach a useful lesson to practical photographers. No one could have seen the heliochromoscope without being struck by the ingenuity of its construction, and the marvellous skill with which the reflecting surfaces were arranged. The little contrivances for getting rid of double images formed by reflection from the back and front of a plain glass mirror were admirable. Reflections from plain glass used for other work had bothered him so much that he had had to abandon such mirrors, and use the surface of a prism, but Mr. Ives had got rid of the evil in another way, and made the two images coincide by using a very slightly prismatic glass. The little instrument was a masterpiece of ingenuity, and he hoped that when Mr. Ives came again next year he would have still further developed this very instructive process. The time was evidently coming when people would not be content with ordinary photographs as lecture illustrations of machinery, or anything else, but would require all objects to be portrayed in their proper colours. He concluded by proposing a vote of thanks to Mr. Ives, which was carried unnimously.

MEETINGS OF THE SOCIETY.

APPLIED ART SECTION.

Tuesday evening, at Eight o'clock:—

MAY 30.—HORACE TOWNSEND, "American Silver Work."

Mr. James Dallas, who was announced to read a paper on "Devonshire Pottery," on the above evening, has been prevented from doing so.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, MAY 23 ... Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. L. S. Horsburgh, "The Waterloo Campaign."

Medical Chirurgical, 20, Hanover-sq., W., $8\frac{1}{2}$ p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. Mr. W. England, "The Daguerreotype Process."

WEDNESDAY, MAY 24...Geological, Burlington-house, W., 8 p.m. 1. Lieut.-Gen. C. A. McMahon, "Notes on Dartmoor." 2. Mr. A. J. Jukes-Browne, "Some Recent Borings through the Lower Cretaceous Strata in East Lincolnshire."

Royal Society of Literature, 20, Hanover-square, W., 8 p.m.

Patent Agents, 63, Chancery-lane, W.C., $7\frac{1}{2}$ p.m. 1. Discussion on Mr. E. Carpmael's paper, "Preliminary Examination into Novelty." 2. Mr. John Hayes, "Section 103 of the Patents, Designs, and Trade Mark Act, 1883."

Linnean, Burlington-house, 3 p.m. Annual Meeting.

THURSDAY, MAY 25...Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mrs. Finn, "The Temple of Jerusalem."

Royal Institution, Albemarle - street, W., 3 p.m. Dr. R. Bowdler Sharpe, "The Geographical Distribution of Birds."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. W. B. Sayers's Paper, "The Prevention and Control of Sparking; Continuous Current Dynamos without Winding on the Field Magnets; and Constant-Pressure Dynamos without Series Winding."

Camera Club, Charing-cross-road, W.C., 8 p.m. Mr. H. Blackburn, "The Book of the Future."

FRIDAY, MAY 26...United Service Institute, Whitehall-yard, 3 p.m. Colonel H. Bengough "Dress and Equipment."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. H. Beerbohm Tree "The Imaginative Faculty in its Relation to the Drama."

Clinical, 20, Hanover-square, W., $8\frac{1}{2}$ p.m. Annual Meeting.

Physical, Science Schools, South Kensingtou, S.W., 5 p.m. 1. Discussion upon Dr. Lodge's paper, "The Foundations of Dynamics." 2. Mr. A. P. Trotter, "A New Photometer." 3. Prof. S. P. Thompson, "Notes on Photometry." 4. Mr. C. J. Woodward, "Exhibition of a Vibrating Bar."

SATURDAY, MAY 27 ... Botanic, Inner-circle, Regent's-park, N.W., 3.45 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. C. Mackenzie, Falstaff: a Lyric Comedy by Boito and Verdi.

Journal of the Society of Arts.

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FRIDAY, MAY 26, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

The Society's *conversazione* is fixed to take place at the Imperial Institute, South Kensington (by permission of the Executive Council), on Wednesday evening, June 21.

Each member is entitled to a card for himself, which will not be transferable, and a card for a lady. A limited number of tickets will be sold to members, or to persons introduced by a member, at a charge of five shillings each, if purchased before June 14. After this the price of tickets will be seven shillings and sixpence.

Further particulars as to the arrangements will be announced in future numbers of the *Journal.*

APPLIED ART SECTION.

On Tuesday evening, May 30, at Eight o'clock, a paper on "American Silver Work" will be read by Horace Townsend.

EXAMINATIONS, MARCH, 1893.

The results will be issued in a few days to the various centres of Examination, and copies of the list sent for distribution to the successful candidates.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 9, 1893; Edward J. Poynter, R.A., in the chair.

The paper read was—

PRIMITIVE ART IN EGYPT.

By Professor W. M. Flinders Petrie.

The earliest condition of art in Egypt stands in a far different light to that of the history of art in other countries. In the first place, it is as early as, or earlier than, any other source of art that we know. Other countries have largely borrowed from Egypt and from Mesopotamia; but these two great deltas have not had any external influence acting on them; they stood far in advance of the civilisation of the rest of the world in the early ages, and their art appears to be the outcome of the first stable and well-organised governments that were known.

Tranquillity, and the command of large resources, were needful before any great progress could be made in architecture or the imitative arts; and no land appears to have enjoyed such conditions before the dawn of the historical period of Egypt. We have, then, to deal with a state of things in which art was in course of actual organic growth, free from the influence of any external guidance, and with only its own antecedents to build upon.

In another respect it also stands apart, owing to the absence, so far, of all traces of its origin and rise. We are still as much in ignorance as ever of the course of its development. Where the tentative stages are to be found which led up to the triumphs of Dynasty IV. is, as yet, a mystery. Certain sculptures, which are undoubtedly very early, have been assigned to Dynasties II. and III., solely on account of the style. But there is no absolute evidence of the date of a single sculpture or a single block before the first king of Dynasty IV., Snefru (the predecessor of Khufu, or Cheops), under whom we find some of the most perfect works that ever were executed. The rise and the course of this art are still buried; and it is only by inferences and side-lights that we can at all estimate what came before Dynasty IV.

In one line, however, there are remains of an earlier style. The rock carvings of Upper Egypt certainly date back to a long prehistoric age; an age when the ostrich and elephant were familiar in Egypt. But these rude figures have no relation to the art of historical times; and we should as soon learn the history of the Parthenon from the weapons of the stone age in Greece as trace the Egyptian schools in the rude carvings of the primitive man.

The oldest sculptures that we know are characterised by being in relief, and by the minute care with which the details of the figures and of the hieroglyphics are wrought. These signs, always in relief, are really elaborate sculptures of distinct objects, and

not merely images for an idea—more or less simplified—as they became in later times. This general carving in relief has been very happily explained in connection with the idea of expressing messages or records by means of actual objects; and from the stage of sending a group of symbolic things, such as a bird, a fish, an arrow, a plant, or other real articles, tied or attached to a board in a given order, to the stage of making similitude of them in relief, is a shorter step than the next change, when these carvings become worn down into the expression of mere sounds. Hence the system of these earliest high-reliefs, so elaborately finished, really takes us back to the very origin of writing; and in their completion and detail we see the incompletion of the great invention to which they led.

Similarly the care, the detail, the lifelike expression of the early figures is due to the sincere belief that as images of the man, representing all that he appeared to the eye, the invisible part of him might then find an earthly home as in his actual body during life. Probably the earliest carvings that we know are the wooden panels from the tomb of Hesi, 4000 B.C. The signs are in very high-relief, elaborately cut, and placed together in inexperienced arrangement. The carving of the figures shows the same care of detail. The muscles are fully modelled and exaggerated, and from the exact maintenance of the expression in these figures the face is clearly a careful portrait. The aim was to produce as exact a copy of the man as possible, without omitting any points which could add to the reality of the image.

Yet we see that a certain model was already established, a model which lasted down to the latest times. The face is fixed, the left leg is advanced, and the manner shows that a settled type had been well practised, and that the idea of variation and choice of attitude was already banished. Hence this, as well as the perfection of the technical work, shows the close of a long time of tentative trials, and a long accumulation of experience.

The first thing that a Western observer remarks on the Egyptian pose is that it is an impossible combination according to our ideas. We see the face in profile, the eye full-length, the chest in front view, and the legs sideways. But before we condemn this as contrary to nature, it is well to see what the nature of a modern Egyptian is, and how far our ideas are correct. To avoid all ideas of posing for the subject, I have selected a figure of a boy from a large group, which was photographed without any special aim by a Cairo dealer. In this kneeling figure we see the profile of the face, the eye full, the chest in front view, and the legs sideways. Everything that we have heard condemned as unnatural and impossible in the ancient sculptures is seen in the modern native, without any constraint, and simply taking an easy position. This shows what is the true idea of the conventional Egyptian pose; it is a three-quarter view, modified by the omission of the much foreshortened parts beyond the profile—a simplification which was essential to an outline system of representation.

Fig. 1.

Rahotep and Nefert. (Ghizeh).

The earliest figures which can be dated to a fixed reign are the statues of Rahotep and Nefert, belonging to the time of Senefru. These, as among the greatest treasures of the Ghizeh Museum, may be familiar to many; but they are always worth review, as showing the strength of the primitive work. The lifelike treatment, the exact copying of the real person, the individuality, is so natural that we are almost apt to overlook its art. Yet there is not a single statue of later ages in Egypt which can be put by the side of these without appearing crude and lifeless. They belong to the higher types of race in the country; and the vigour of Rahotep, and the placid beauty of Nefert, are very different from the lower races. In the Queen Mertitefs another type is

seen, and a different treatment as well. The physiognomy and the manner are both of them much more akin to the primitive Babylonians; and many links appear between the aboriginal Egyptian and the Mesopotamian, which seem to point to a common origin of arts and ideas.

Fig. 2.

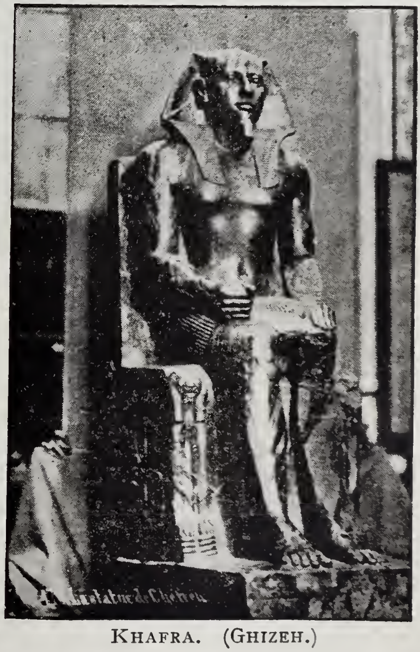
Head of Nefert.

This same character is seen in some early statues at Ghizeh; and the physiognomy has an affinity to that of the well-known scribe in the Louvre. He appears to represent a mixed type, between the aboriginal Egyptian and the higher type of invaders who founded the dynastic kingdom.

Descending a couple of reigns, the next important example of the primitive art is the statue of King Khafra (Fig. 3). The front view is familiar in many illustrations, its royal dignity and supreme capacity. But the side view gives a very different light on the expression; we there see the bright intelligence and sweetness of the face, without losing any of its nobility (Fig. 4). The sculptor has succeeded in combining a most complex expression: august dignity without hauteur or coldness; unconquerable firmness, yet with keen intelligence and vivacity; rigid rule with a winning grace; and monumental gravity with an almost humourous smile. Yet this is the earliest royal figure known, and carved in one of the most intractable materials.

Besides work in limestone, as Rahotep and Nefert, and in diorite, as Khafra, the early sculptors deal with wood in the round with great success. Two of the most vivacious

Fig. 3.



Khafra. (Ghizeh.)

portraits they ever carved are the so-called

"Shekh-el-Beled," or wooden man, and the figure of his wife. The latter, which is less celebrated, is perhaps the finer piece. The vigour of the pose, the racy expression, and the whole energy of the work are unexcelled.

The figure of the husband, though excellent, has not an equal inspiration of nature. The best point of view is the front face, and we see in that somewhat the same cast of seriousness that overclouds Rahotep. It is noticeable how, in both of these pairs of figures, the sense of responsibility shows in the man's face; while, in the women, the artist has shown a placid satisfaction in one, and an audacious raciness in the other, without any of the more weighty expression.

This type of face is peculiar to the earliest period of work. Any sculpture of this age is unmistakable in the solidity of its style, and the somewhat heavy but very capable expression. A small statue, now at Bologna, for instance, though without any inscription, could not possibly be referred to any later age.

Besides figures at rest, the primitive people often represented workers engaged in daily tasks. The spirited figure of a woman grinding corn (now at Florence) is almost as lifelike as the more ambitious statues which we have noticed; but the expression is here that of attention to a duty, and not the easy indifference of the other women (Fig. 7, p. 678.) Other statuettes represent potters moulding jars by hand, exactly such jars as are found handmade in the workmen's heaps of the pyramid builders. In these men we see the stolidity of the lower and coarser classes, without any of the intelligence and brightness of the higher people. In the statue of the kneeling servant the aim is that of simple submissiveness—humbly waiting, with folded hands, for his master's orders—an air totally different from the decisive manner of the statues of the superiors.

Besides this class of strictly personal portrait sculpture, the early art also excelled in the lesser figures of the attendants and servants carved in the tombs. The original object of the sculpture was religious, as in the portrait statues. In those, by the exact copying of the external man, the soul was provided with a suitable home; and, by the figures of the servants and animals engaged in all the need-

Fig. 4.

Bust of Khafra, from Statue.

ful processes of ordinary life, the master was assured of the continuance of all those services for his life in the statue. The sequence of ideas is strictly logical, if we once begin by conceding the utility to the soul of the artificial man—or statue—as a residence; though the outcome of the reasoning, and the pictorial provision for all the needs of the body seem incongruous at first sight.

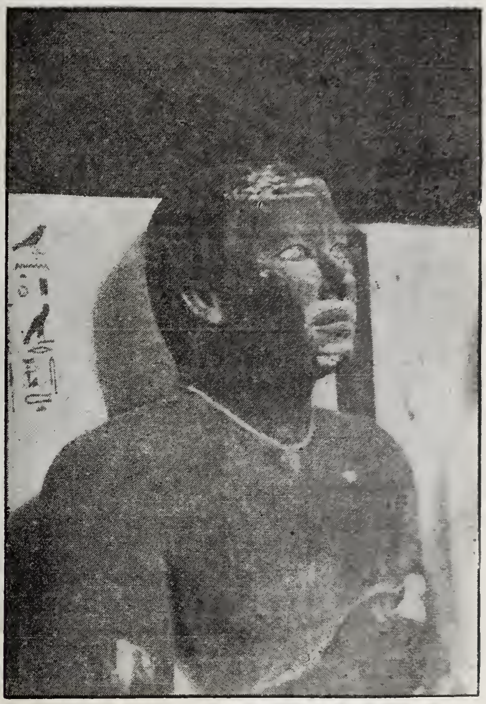
These lesser sculptures, like the statuary, are finest in the earliest periods yet known. The theoretical need of exactness and reality was most felt when the efficacy of the figures was most esteemed; and as time passed a less and less exact and careful treatment was

FIG. 5.

WIFE OF THE "WOODEN MAN." (GHIZEH.)

thought equally availing, until the rudest scrawl was substituted for the real image. The tomb of Rahotep, at Medum, from which the lifelike statues came which we have already noticed, contained also some of the finest relief sculptures that are known. The larger figures, and those most within reach, have all been ruinously mutilated in the recent years since the tomb was opened; and, indeed, the only method of preserving monuments that has yet proved successful in modern, as in ancient times, is to bury them safely; no guardian is so efficient as ten feet depth of loose earth. The upper figures are, however, still in good state, and we there see the triumphant fishermen carrying a huge "fighting-fish" hung from the oar between them; the spring of their walk, and expression of their zeal are excellent. Another scene, of a herdsman leading an addax, shows an entirely different feeling; here he is coaxing it along, partly by force, partly by favour. In the group of fishers drawing a net to land, the idea is simply the steady performance of a heavy duty; but the man who has sat down in the shade of the lotus to split the fish and spread them out to dry is far more leisurely. The animals are

FIG. 6.



BUST OF RAHOTEP.

treated with as much expression as the human figures; the elastic prowling walk of the leopard, and the fugitive manner of the hunted wild dogs are most characteristic. In another group a little boy is supposed to be in charge of a baboon and a monkey; the baboon has, however, secured the boy's wrist, while the monkey is intent on pulling the tail of a crane in front of him, and is just going to be rewarded by a kick of the crane's leg, which is rising. There are few, if any, ancient figures of animals which surpass these in the vivid sense of their peculiarities and action. One of the most celebrated tombs, that of Tih at Sak-

kara, which belongs to the following dynasty, is far inferior in the delicacy of the work and the power of expression; and this, in turn, is better than any later Egyptian work. We see then, that in each respect, in statuary, in figure reliefs, and animal sculpture, the earliest work yet known in Egypt is emphatically the best, and has a vitality and realism which raises it far above all later efforts.

What came before this is the great problem. Where did these artists form this style, which —within its limits—is so technically perfect? Where did they acquire this close observation and feeling? When did the preparatory stages come? Judging by what has since passed, there may have been but a short transit from rude and stiff work to this finest period. In Greece how much passed in one century before Phidias! In Italy how great is the step in one century before Botticelli! So in Egypt, a single century may have bridged the space from cumbrous efforts to the high pitch at which we find the artist, in the first remains which we can date.

But in one direction we can reach back to the art of the still earlier ages of which no actual remains are yet known. The philologist has formed a sketch of the civilisation of races long before all written record, by the evidence of the words and names embedded in their languages. In the same way, we may form a picture of the civilisation of Egypt at the age when writing was developed, and when abstract ideas came to be denoted by figures of symbolic objects. This stage of their civilisation cannot have long preceded the time of the earliest art which we have noticed; as, at that period, the style of the hieroglyphic signs was very elaborate, and they were still regarded as symbolic pictures, rather than as arbitrary marks for sounds or ideas.

Fig. 7.

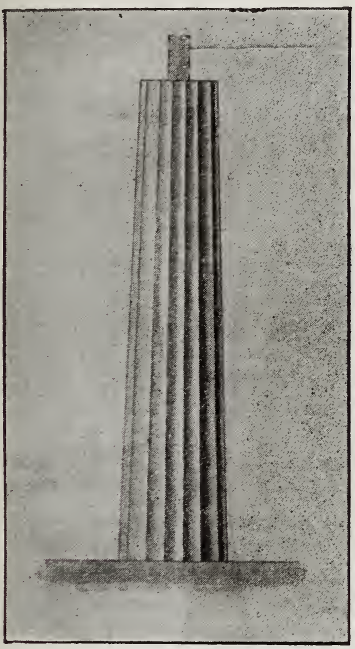
Corn Grinder (Florence).

We learn, then, that at the time of the development of the hieroglyphic writing, there were more than the mere elements of civilisation; in fact, a high level is in many respects indicated. The chisel and adze were used, made of metal—doubtless copper—and attached to wooden handles. The two-handled plough was in use, as well as sledges for drawing heavy loads. Games were played on portable game boards. And while writing was yet being formed, the use of signet cylinders of engraved stone, and the scribe's palette and pencase, all came into use. We learn that industrial arts and organisation preceded the elaboration of the religion, when we see the high priest of Memphis entitled the "great commander of workmen," the high priest of Mendes the "chief of the soldiers," and the high priest of Sebennytus "the warrior." These are the glimpses of pre-historic Egypt preserved to us in the hieroglyphs and titles.

Most happily we have also thus preserved an outline of the pre-historic architecture. The oldest actual buildings known—besides the Pyramids, which stand apart from all later forms—are two temples, that of Ghizeh, built by Khafra, and that of Medum, built by Senefru.

The temple of Khafra—the third king whose works are known—is of extreme simplicity; rectangular halls of red granite with plain walls, only decorated outside by panelled work. This has been taken hitherto as the type and limit of the early architecture. The temple of Senefru—the first king whose works are known—is even simpler. There is no granite, only limestone of the neighbouring hills; there is no ornament whatever, only perfectly plain walls, inside and out. From these it might seem that no decorative efforts had yet touched the profession of building, and that construction was not yet an art. But the

FIG. 8.



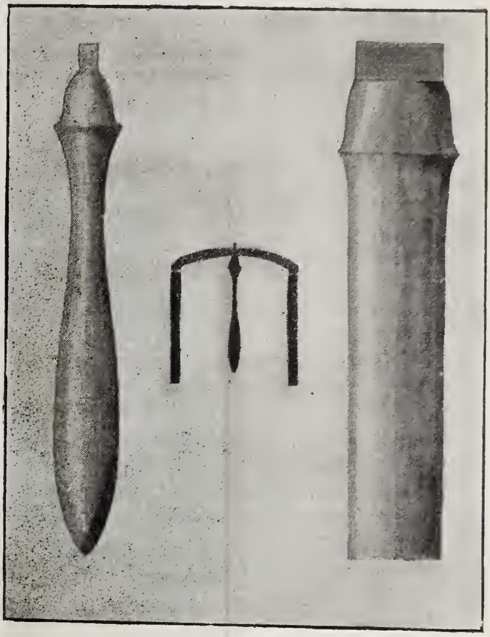
OCTAGONAL COLUMN.
(Medum hieroglyph.)

hieroglyphs show how far wrong such a conclusion would be. Contemporary with this earliest and simplest known temple, the inscriptions in these tombs show us that octagonal columns were in use, tapered to the top, and fluted on the sides. These are probably derived from large posts or stems of trees, and are quite as advanced as the well-known columns of the tombs at Beni Hasan, the so-called proto-Doric. Thus we learn that this type belongs to an age when even writing was not yet formed.

Another type of column was also in use, apparently derived from the wooden tent-pole. Being the greatest piece of the tent, it was used in expressing greatness. It has the curious bell top above the lotus flower; which afterwards became developed into the ugly columns of Thothmes III. at Karnak, with a bell capital. This column appears as the central support of a dwelling, in the section view of a booth, which is the hieroglyph for a festival.

Yet another type was in use, with a defined capital. From the banding around the neck of it, it appears to have been first formed of a cluster of some yielding material. Probably it was a bunch of maize stalks tied together,

FIG. 9.



LOTUS COLUMN, MEDUM.
HIEROGLYPH FORM, MEDUM.
COLUMN AT THEBES, DYN. XVIII.

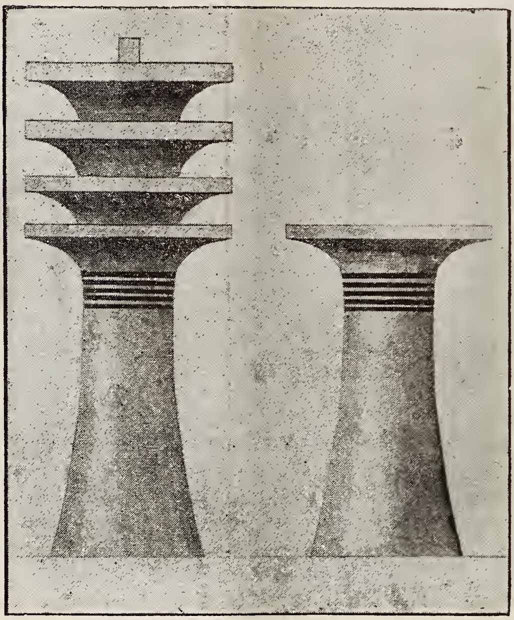
with the tops crushed outward, and then plastered over with mud. It became, however, one of the principal types of the early period; and a row of such columns, seen with the capitals one over the other, became the emblem of stability or firmness. These columns appear in a very curious drawing of a building painted in Dynasty XII.; that shows us a front supported by such columns, crowned with a pediment, borne by a diminishing row of lesser columns filling the tympanum. That this is not merely a sport or stray fancy is certain, from two carvings in the Louvre, one in ivory, the other in wood, which show just such a design copied for small decoration. In

the ivory example the window openings in the tympanum are filled with lotus leaves tied together in a manner which is most usual in the Dynasty IV., and it seems not unlikely that this design belongs to the same early period as the first examples of the columns.

All of these types of columns, then, go back to the primitive time of the development of writing, before any of the monuments that we know of as yet. One other feature we can also glean from the same source. The decoration of a cornice with a row of serpents, or cobras, reared up with the hood expanded, was also known in this primitive epoch; and this serpent must already have been used as an emblem before it would be adapted as a symbol on the front of the king's courts of justice.

Leaving this revelation of the unknown age, and coming to the earliest historic period, we find a fourth form of column in use, with a bold capital, a roll at the neck, and a deep torus base. This is sculptured in low-relief on either side of a doorway, but is clearly copied from a column in the round. The source of this form is suggested by a figure of a bowl, placed in a tall, cylindrical stand, which occurs in the same tomb, and which unmistakably resembles it.

Fig. 10.



Column with Capital.
(Medum hieroglyph.)

The principal remaining type of column—the palm capital—I have not yet found earlier than the Dynasty XII., or about 2500 B.C. Hitherto, it has only been recognised in the Dynasty XVIII., but an ivory carving of the Dynasty XII. shows it completely developed. We can now believe, therefore, that the brilliant granite columns of some temples of this type date back to the Dynasty XII.; and it would be not at all surprising if it proved to be as early a type as any of the other forms of column which we have noticed. The material for it is so abundant and so obvious in the palm groves of Egypt, that it would be strange if it came late in the invention of types. In one point, the palm is among the oldest materials, as the typical cornice of Egypt is derived from the palisade of palm branches, plastered over to form an enclosure, and with the tips left free and curling over, as a fence along the top. Such may be seen now around the court-yard of a peasant, and such was clearly the source of the overhanging ribbed cornice so essential to almost every Egyptian building.

We have now reviewed the primitive art of Egypt, so far as our present knowledge and our recent discoveries enable us to grasp it. The sculpture we, as yet, only touch at its

finest development, and the rise of it remains one of the most fascinating historical questions which await solution. The architecture we have been able to trace back to the age of the invention of writing, and we find even then that all the important types of later ages were already in existence. Where the steps which led to this art and this architecture are yet to be found is a mystery. If they existed in Egypt it seems almost incredible that they should not yet have been seen anywhere. Some few statues of an extreme simplicity appear to possibly precede those which I have named; but yet there is no trace of any dated remains. Whether the first three dynasties actually reigned in Egypt, and filled the

FIG. 11.

COLUMN WITH CAPITAL. (TOMB AT GHIZEH.)

centuries assigned to them by later histories, may be questioned. Possibly we are to regard the historical lists which name these kings as a rearrangement of materials in the literature two or three thousand years later, in which those lists are first found by us. Some indications suggest that the dynastic Egyptians had not long been in the land before Dynasty IV.; possibly only for a century or two. If so, we might find traces of the rise of their art in some other country; and Southern Arabia seems more likely than any other land to have been the source of the conquering race. The Mesopotamian affinities seem rather to be with the aboriginal race of Egypt. Here, then, we must pause, and hope that some happy discovery may enable us to understand, in future, the source and history of an art which is one of the most perfect and vital of any of the various styles to which different countries have given birth, and which, to some extent, underlies all the products of later times.

DISCUSSION.

The CHAIRMAN said the paper, though interesting and instructive, hardly offered much scope for discussion, inasmuch as he looked upon the information which Mr. Petrie had given them rather as a means of instruction than as matter for argument. The author had brought to bear on the question of architecture especially a large amount of minute observation, not only through his study of the early hieroglyphics, but also of modern Egyptian constructions, which, looking at the permanence of institutions, in that country, went far to explain methods of building which were in use some 6,000 years ago. The description he had given of a fence of palm branches, the curving foliage of which formed a cornice, whilst the stalks covered with plaster formed the wall, seemed to explain very well the form of the curved cornice, and to throw an entirely new light on the origin of some of the Egyptian forms of architecture. The columns in the temple of Thothmes III. with the bell capital reversed had always appeared to him to be simply a caprice on the part of the architect, introduced for the sake of variety, but Mr. Petrie had given a very excellent explanation of this, as an imitation of the tent pole, as portrayed in the early sculptures. Again, everyone must have been struck with the extraordinary amount of life and humour in the early Egyptian sculptures, which might, to an equal extent, be seen also in the paintings of a later period, in the British Museum, and as portrayed in Lepsius's book. Another point of great interest was the historical inferences which Mr. Petrie had drawn from the different types of faces. Mr. Petrie had made a special study of this subject, and had published a series of photographs, in which he had collated the types of different nationalities represented on the monuments of various periods, as seen in the lines of prisoners in the processions, and the conquering races which founded the dynasties. He proposed a hearty vote of thanks to him for his paper.

Mr. J. J. STEVENSON said that any one who had read Mr. Petrie's book on the Pyramids of Ghizeh, or who had heard him to-night, must have been struck with his wonderful power of reading the old history of Egypt by the light of the present habits of the people. In that book he threw a new light on the few lines of Herodotus, where that author said the priests told him that the Pyramids were built by three months' levies. It had been generally supposed that the work was accomplished by a great system of oppression, but Mr. Petrie had pointed out that, on the contrary, it might have been a great system of

relief-works set on foot when no other work was available. Even those who had been in Egypt must have heard that evening a good deal that was new to them, and they would all hope to hear more on some future occasion. Mr. Petrie evidently had that genius which consisted in seeing what no one else had ever seen before, though they had looked at the same things.

Mr. PHENE SPIERS said that some of the photographs which had been shown that evening were the most interesting things he had ever seen. He was already acquainted with Mr. Petrie's theories with regard to the origin of certain architectural forms, but he had not before heard his explanation of the origin of the palmetto cornice. It was a point he had thought over for years, and had made several guesses at the explanation, one being the fact that plants and weeds often grew on the tops of old walls, and hung over in a sort of fringe, and he thought that possibly this sort of growth was encouraged by the Egyptians in order to consolidate the top of the wall and prevent the sun acting too strongly, or the water getting in; but Mr. Petrie's idea of the palisade wall seemed infinitely preferable, especially as it was strengthened by the fact that such a fence was a better protection than any ordinary wall, which could easily be scaled by agile Egyptians. Mr. Petrie knew a great deal more about the Doric column than he had said. He was the first to discover in Kahun the original wooden column which, no doubt, gave the form to the well-known polygonal column. There was a difference of opinion as to the origin of the stone column and the wooden column. As a rule, it was generally assumed that, if a column had a base, it must have been originally in wood, but, if it had no base, it might have been in stone, the reason being that a wooden column standing on the ground without a base would have its lower portion eaten away or rotted with moisture. The Japanese coated the lower portions of their columns with bronze or lacquer, to preserve them. Mr. Petrie discovered, in the town of Kahun, one or more columns in wood, the original types of those proto-Doric columns to which he had referred. He should like to know if he had formed any theory as to the origin of the antæ, or beams placed against the wall, to assist in carrying the beam which rested on the stone column. They existed in Egyptian work, as they were found in the tombs of Beni Hasan: at the further end, there was a projecting pilaster of stone, which accorded with the *anta* of Greek architecture. Dr. Schliemann's discoveries had proved beyond doubt that, in the palace of Tiryns, these wooden beams were placed against the wall to support the architrave, the builders not trusting to the walls alone, which were either of mud, or stone laid in liquid clay. The wooden antæ were not found, having rotted away, but the mortice holes in which they had been fitted still remained. No reference had been made to the lotus column which was found in the tombs at Beni Hasan, and he had seen very early examples in M. Mariette's book, which ascribed them to Dynasty V.

Mr. PETRIE said he had not hitherto been able to find any earlier example of the lotus column than those to which Mr. Spires had referred, or of the antæ, and he had not, therefore, mentioned them.

Mr. HUGH STANNUS said the Section was privileged in being presided over by Mr. Poynter, whose grand picture of "Israel in Egypt," would be in the recollection of many present. He (Mr. Stannus) had been conceited enough to think that he knew something about Egyptian work, having studied it for some years, so far as opportunity allowed, but he felt to-night that he had been to school again; and he was very grateful to Mr. Petrie for the light thrown on a very obscure subject; and was glad that he was now in an academical position, which would allow him still further to elucidate it.

The vote of thanks was carried unanimously, and the proceedings terminated.

Miscellaneous.

EMPLOYMENT OF WOMEN IN PUBLIC OFFICES.

The *Journal des Economistes* says that France was the first country to admit women to places in the postal administration, and their engagement has proved so satisfactory that it is the expressed intention of the authorities to employ them in preference to men wherever it is possible. In 1892, the French Post office female staff consisted of 8,128 persons. In the United Kingdom the female staff of the Post-office consists of 25,928 persons, out of a total staff of 125,762. Deducting 23,000 letter-carriers, this gives a proportion for women of 25·2 per cent. There are 20,148 women employed in England, 2,507 in Scotland, and 3,273 in Ireland. In Switzerland, for vacancies in the postal and railway department, women are eligible equally with men, and out of a total staff employed in this department, numbering 7,379, 869 are women. In the telegraph and telephone administration there are 194 women employed, of whom 77 are telegraphists and 117 telephonists. Several of the Swiss railway companies employ women in various capacities. In Holland only eight classes of employment in the administration of posts and telegraphs are open to women, the latter numbering 130 in the postal service and 56 in the telegraph service. The railways, which are private undertakings, employ 720 females. In Italy, the administration of telegraphs employs 18 female clerks, 237

auxiliaries, and about 350 supplementary clerks. In the postal department women are employed to the number of about 150. In Spain, nearly all the positions in telephone offices are occupied by women. In the telegraph offices the employment of unmarried women or widows is authorised, and the experiment has been so successful that the Government have decided to make the system general throughout the country. In Sweden, 24 permanent women clerks and 250 female temporary clerks are employed by the State railways. In the postal service women are admitted to all employments, except letter-carrying, but only unmarried women or widows are eligible. In the telegraph offices in Sweden an exceptional circumstance is noted, that is, the number of women employed is greater than that of the men, the figures being 459 of the former and 252 of the latter. In Norway, a Bill is before Parliament having for its object the admission of women to all forms of public employment. In the last ten years many have been engaged in the public offices, the greater part of them receiving the same salaries as men. For admission to places as telegraphists the conditions are the same for women as for men. At the present time there are 112 women telegraphists and a certain number of assistants employed. In the post-offices the number of females employed is about 120. In Denmark, since the year 1889, when appointments in the postal and telegraph departments were thrown open to women, 163 such appointments have been made. Women have the same prospects and the same emoluments as the male clerks. It is not necessary to pass an examination to obtain an appointment in a Government office. Women are admitted to various posts in the railways and may become "station-masters," and many places such as shorthand-writers in the Danish Parliament are filled by them. In Finland, the postal administration employs, exclusive of letter-carriers, 631 persons—405 men and 226 women, while as regards the postal and railway departments, these are under Russian direction, and many places in them are filled by women. In Iceland, women are eligible for all appointments in the postal service. In Germany, the telephonic service is almost exclusively in the hands of women, and the postal and telegraph offices also give employment to them. In Austria, the postal service employs 250 persons of the female sex, and the telegraphs 630, but only unmarried women and widows without children are eligible for appointments. The compilation of statistical returns is confided by the Austrian Minister of the Interior to a female staff. In Hungary, post-offices, telegraphs, and telephones are under one direction, employing 2,267 women; while in the employment of the State railways 247 women are engaged. In Roumania, 85 women are engaged in the postal and telegraph administration. In Russia, the postal and telegraph administration only admits into its services as women clerks young girls, widows, and married women whose husbands are connected with the department. The number of female telegraphists in Russia is 874. In the Russian railways the employment of women is very general, and they are admitted under the same conditions, and with the same prospects as men. In the British colonies large numbers of women are employed in postal, telegraph, and railway services. In Newfoundland, positions in postal and telegraph offices are open to all British subjects without distinction of sex. Latin-America has lately manifested a desire to follow the example of European countries in respect to the employment of women, and Colombia has established a school of telegraphy divided into two sections—one for men and the other for women. The new Republic of Brazil has admitted women not only into the service of telegraphs and telephones, but into all the Government departments indiscriminately. In Chili, a large number of places are filled by women in the postal and telegraph departments, and also in other Government offices. In addition, the position of conductor on the tramways is, by a decision of the Government, always to be filled by women. The United States of America gives employment in its various public administrations to 14,692 women, of whom 6,650 are engaged in post-offices.

General Notes.

Trips to Chicago.—The first of the Polytechnic weekly trips to the Chicago Exhibition arrived in New York on the 19th inst. The parties travel from Liverpool every fortnight, and from Southampton every Friday and Saturday.

National Exhibition at Budapest. — The Science and Art Department has communicated to the Society a translation of a note that has been received, through the Foreign Office, from the Austro-Hungarian Ambassador respecting a National Exhibition to be held at Budapest in 1896. The Exhibition will coincide with the thousandth anniversary of the foundation of Hungary, and is to be under the patronage of his Imperial and Royal Apostolic Majesty. His Excellency Count Deym, writing to the Earl of Rosebery on the 28th ult., says:—"The Exhibition will be so extensive that it will have great interest for foreign countries, and the Government of the King trusts that no important Exhibition will be arranged elsewhere for the same date, as, owing to the exhibition at Budapest, Hungary would not be able to take part in it."

Friendly Societies.—The 72nd annual movable committee of the Manchester Unity of Oddfellows was opened, at Southampton, on the 22nd inst. The President stated that he found himself able to point to admissions in the past 12 months that had positively broken the record. The number of admissions by initiation in Great Britain and Ireland had been 46,721, and the total number of members on January

1 was 709,403. The statistics relating to the juvenile societies showed that they also were making steady progress. The number of juvenile members on January 1 was 82,242, an increase during the year of 8,426. The returns for 1891 showed receipts of £1,030,655, and payments of £786,941. The accumulated funds of the order amounted to £7,844,462. The Order of Druids met at Nottingham on the 23rd inst. The Grand Master reported that, notwithstanding the trade depression, there had been a considerable increase of members and a net financial gain on the year of £15,514.

The Forests of Macedonia.—The French Consul at Salonica, in a recent report, says that the forests of Macedonia are of great importance by reason of their extent and the variety of the woods, and although the felling of the trees increases from day to day to such an extent that the districts of the littoral will soon be completely denuded, the area under forests in Macedonia is still very considerable. It is estimated at about 200,000 hectares (hectare = 2·47 acres) in the sandjak of Salonica, 140,000 hectares in Monastir, and 200,000 hectares in Kossovo, and this immense extent of forest-land, which might prove a source of great wealth to the country, is allowed to remain practically unworked. The State owns three-quarters of the forest area, the remainder belonging to the various communes and to private persons. It is only those districts, which are situated near the sea and the railway from Salonica to Mitrovitza, that are at all utilised, and these furnish planks, timber for building purposes, railway-sleepers, and particularly charcoal.

Hodgkins Fund Prizes.—About a year and a half ago Mr. T. G. Hodgkins, of New York, made a donation to the Smithsonian Institution, the income from a part of which was to be devoted "to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man." In pursuance of the donor's wishes, the Smithsonian Institution offers the following prizes to be awarded on or after July, 1894:—1. A prize of $10,000 for a treatise embodying some new and important discovery in regard to the nature or properties of atmospheric air. 2. A prize of $2,000 for an essay upon (A) the known properties of atmospheric air considered in their relationships to research in every department of natural science, and the importance of a study of the atmosphere considered in view of these relationships. (B) The proper direction of future research in connection with the imperfections of our knowledge of atmospheric air, and of the connections of that knowledge with other sciences. 3. A prize of $1,000 for a popular treatise upon atmospheric air, its properties and relationships (including those to hygiene, physical, and mental). A medal is to be awarded annually or biennially for important contributions to our knowledge of the nature and properties of atmospheric air, or for practical applications of our existing knowledge of them to the welfare of mankind and it is probable that special grants may be made to specialists engaged in original investigation upon this branch of science. The compositions may be written in English, French, German, or Italian. Communications should be addressed to S. P. Langley, Secretary of the Smithsonian Institution, Washington, U.S.A.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 29 ... Surveyors, 12, Great George-street S.W., 3 p.m. Annual Meeting.
Geographical, University of London, Burlington-gardens, W., 2½ p.m. Annual Meeting.

Tuesday, May 30 ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Art Section.) Mr. H. Townsend, "American Silver Work."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. L. S. Horsburgh, "The Waterloo Campaign."
Civil Engineers, 25, Great George-street, S.W., 8 p.m. Annual Meeting.

Wednesday, May 31 ... Patent Agents, 63, Chancery-lane, W.C., 3 p.m. Annual Meeting.

Thursday, June 1 ... Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, 3 p.m. 1. Mr. W. B. Hemsley, "Polynesian Plants collected by J. J. Lister." 2. Miss A. Lorrain Smith, "The Anatomy of a new Plant—*Melastomaceæ*, or *Gentianaceæ*, genus novum." 3. Dr. Baur, "Observations on the Temperature of Trees made in Boulder, Colorado."
Chemical, Burlington-house, W., 8 p.m. Professor Meldola and Mr. F. B. Burls, "Azo Compounds of the Ortho Series." 2. Dr. Collie, "The Fluoresceïne of Camphoric Anhydride." 3. Messrs. J. E. Marsh and J A. Gardner, "The Action of Phosphoric Chloride on Camphene." 4. Mr. A. Pears, jun., "The Composition of Jute produced in England"
Society for the Encouragement of Fine Arts, 8 p.m. *Conversazione* in the Galleries of the Royal Institute of Painters in Water Colours.
Royal Institution, Albemarle-street, W., 3 p.m. Dr. R. Bowdler Sharpe, "The Geographical Distribution of Birds."

Friday, June 2 ... Royal Institution, Albemarle-street, SW., 8 p.m. Weekly Meeting, 9 p.m. Prof. Osborne Reynolds, "Study of Fluid Motion by Means of Coloured Bands."
Geologists' Association, University College, W.C., 8 p.m.
Philological, University College, W.C., 8 p.m.
Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

Saturday, June 3 ... Dr. A. C. Mackenzie, "Falstaff": a Lyric Comedy, by Boito and Verdi.
Actuaries, Staple-inn-hall, Holborn, 3 p.m. Annual Meeting.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

No. 2,115. Vol. XLI.

FRIDAY, JUNE 2, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

Alteration of Date.

The Society's *conversazione* will take place at the Imperial Institute, South Kensington (by permission of the Council of the Institute) on *Friday evening, June* 30 (instead of the date previously fixed), from 9 to 12 p.m.

The reception will be held from 9 to 10 p.m in the vestibule, by Sir Richard Webster, Q.C., M.P., Chairman, and the Members of the Council of the Society.

Each member is entitled to a card for himself, which will not be transferable, and a card for a lady. A limited number of tickets will be sold to members of the Society, for the use of their friends, at a charge of five shillings each, if purchased before June 24. After that date, the price of tickets will be raised to seven shillings and sixpence.

Tickets can be obtained on personal application at the Society's House, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, and must be signed by the member to whom it is issued.

Promenade concerts will be given by military bands in the East and West Gardens, which will be specially illuminated.

Further particulars, as to the musical and other arrangements, will appear in future numbers of the *Journal.*

APPLIED ART SECTION.

On Tuesday evening, May 30, Mr. Horace Townsend read a paper on "American Silver Work."

The paper and discussion will be printed in a future number of the *Journal.*

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Monday, May 29. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Sir Frederick Abel, Bart., K.C.B., D.C.L., D.Sc., F.R.S., William Anderson, D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Braddon, K.C.M.G., Major-Gen. Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, Sir George Hayter Chubb, Francis Cobb, Professor James Dewar, M.A., LL.D., F.R.S., Charles Malcolm Kennedy, C.B., John Biddulph Martin, John Fletcher Moulton, Q.C., F.R.S., John O'Connor, Gen. the Right Hon. Sir Henry F. Ponsonby, G.C.B., William Henry Preece, F.R.S., Professor William Chandler Roberts-Austen, C.B., F.R.S., Sir Owen Roberts, M.A., D.C.L., F.S.A., and Sir Albert Kaye Rollit, M.P., LL.D.

Proceedings of the Society.

FOREIGN & COLONIAL SECTION.

Tuesday, May 16, 1893; The Earl of Onslow, G.C.M.G., in the chair.

The paper read was—

ASPECTS OF IMPERIAL FEDERATION, FROM A COLONIAL POINT OF VIEW.

By Westby B. Perceval,
Agent-General for New Zealand.

It is hardly necessary to preface this paper with a statement that I do not claim to express the opinions of any person other than myself. One of the difficulties that surround the subject of Imperial Federation is the absence of any well-defined public opinion about it, for the general practice which has prevailed of being vague and indefinite when discussing this vast and many-sided problem, far from tending towards any solution, has resulted in a somewhat vague and procrastinating condition of mind. This very vagueness has, I know, been hitherto defended, and even recommended, on the ground that the time had not arrived to be exact; but it begins to be time now that the question should be looked fairly in the face,

and so handled that the mind-pictures which have hitherto shadowed it may be converted into practical and business-like realities, or for ever be relegated to the faddist. The Federation League, the only body which claims to represent the movement, has, until now, refused to attempt to formulate a plan, and so far, this policy, or, to speak more accurately, this absence of policy on the part of the League has not been attended with evil consequences. During the ten years' life of the League a considerable advance in popular sentiment, both here and in the colonies, has taken place, owing probably to the very fact that the broad outlines indicated in its programme were not calculated to evoke hostility.

This advance is indicated by the conviction, sufficiently widespread, I believe, to represent the condition of mind of an enormous majority of her Majesty's subjects all over the world, that the disintegration of the Empire would be a fatal calamity, and that its future safety and prosperity depend upon the evolution of some more complete system of national unity than now exists. The people of this country have abandoned that idea of the future of the colonies which found influential support even a few years back, *i.e.*, the idea that they should be cast off as soon as they were old enough to be weaned; and the feeling is growing in the colonies that it is to their interest to retain and strengthen their connection with the mother country. It is wrong, no doubt, to say that the people of the colonies, any more than the people of this country, have any definite ideas on the subject, beyond the instinctive feeling that any action which tends to disintegration is to be condemned and avoided; but this very feeling, the creation of which is owing to a great extent to the efforts of the League, is an essential basis for future action. However, the foundations, thus laid with so much care, must soon be covered by a substantial structure, or they will decay and crumble away, probably never to be laid again.

Contrary to the opinion which is generally held in England, I believe that this inclination towards closer union is stronger in the colonies than here. My reasons are these. Few colonials regard the contingency of their colony becoming an independent State with any but feelings of dismay. They recognise that they could not defend themselves against all possible attacks by hostile powers, that their fertile and unpeopled territories would offer a standing invitation to the people of over-crowded foreign nations to occupy at their expense, and that to set up the expensive State machinery which attaches to independence would be a considerable drain on their resources. In short, the majority of the colonials recognise that, to become citizens of a puny independent State, instead of co-sharers in the powerful empire which they and their forefathers have helped to build up, would be an exchange every way deplorable in its consequences.

Added to this conviction is a belief that the British political system has always proved itself capable of being moulded into such forms as best suit the exigencies of our national development, an historical fact which is constantly being presented to the colonist in some practical shape or other. To him, therefore, the changes in the political constitution of the Empire necessary to effect a more complete and legislative union of all its parts do not present the same difficulties as they do to people here.

On the other hand, the great bulk of the people of the United Kingdom are deplorably ignorant about the colonies, and fail to appreciate their value to the Empire. This condition of things is being slowly corrected, but arduous is the task of those, whether colonial representatives or pressmen, who are called upon by duty or inclination to educate the people of this country to a more intimate and correct knowledge of Greater Britain. The Imperial Federation League has done good work in this direction, and the colonies owe a considerable debt to institutions like the Colonial Institute, that have shared in the task of enlightenment, and I look forward to the great and useful part that the Imperial Institute, which was opened last week under such promising auspices, will now perform as a standing exposition of the economic products of the Empire and as a public educator. The British Press has shared with the British community the sin of neglect as far as the Colonial Empire is concerned; but a vast improvement is taking place here, and great things will result from its conversion. When once the people of these islands are impressed with the potentiality of the colonies for good, and recognise the probable fact that in fifty years time the population, trade, and wealth of those over-sea possessions will be as large as those of the United Kingdom, the willingness to admit Greater Britain to a full partnership in the Empire will manifest itself. I regret to have to think that outside a very influential, but,

nevertheless, a very small section, there is no desire on the part of the British public to admit the colonies to any closer relationship than the loose ties that already exist, and certainly there is no general inclination to make any, even temporary, sacrifice to effect a more intimate union. This, added to the slowness with which public opinion marches in England, and the still greater slowness to give effect to public opinion when it is formed, make me fear that the public opinion of the various portions of the Empire may not, at any time, synchronise in ripening for action.

When I express the opinion that the desire for closer union, as opposed to disintegration, is stronger in the colonies than it is here, I must not be understood to mean that the colonial ideas of union are necessarily the English ideas. Both sets of ideas are doubtless in a nebulous state; but, in so far as they are beginning to assume a shape, we can see enough to demonstrate that there are many points of divergence.

The main thing, however, is that the desire for closer union, based on self-interest as well as national sentiment, is gradually increasing throughout the Empire, and given the will, the problem is to find the way. Taking this desire as a basis, the Imperial Federation League has recently urged the Imperial Government to call together another conference. It has done more, for it has, for the first time in its history, made definite proposals for the consideration of the suggested conference. I join with those who thank the committee for what they have done, and hail the new departure they have taken with satisfaction; and, although differing from much the report contains, I recognise with gladness that, at least, we have in it a foundation for future discussion.

The conclusions arrived at by such a body of men as the special committee must command respectful attention, and keep alive public interest in the subject, and it appears to me that the true way to show appreciation of their labours is to tender, with our thanks, our keenest criticism. In offering some comments on the report, and in selecting certain aspects of federation to discuss, I am probably one of those fools who rush in where angels fear to tread; but the time has now arrived when language should be used to express rather than hide our opinions, or, possibly, absence of opinions on this great problem, and there will have been some wisdom in my folly, if I give any critic an opportunity of contributing any useful thoughts or of brushing away one of the many cobwebs that are spun across the threshold.

The time at my disposal is so limited that it is impossible to go at all fully into even the few points which I intend to touch upon. Imperial Federation has not yet grown into a party question, either here or in the colonies, so I take it there can be no objection to an Agent-General, who has, by virtue of his office, to steer clear of all party politics, offering, in his private capacity, his contribution to the subject. In passing I add that I am not at all sure that much progress will be made until Imperial Federation is forced upon the statesmen of this country and does become a party question. The Federation League now carries on its work entirely free from party lines; but if the movement is to be directed towards the achievement of any practical point, it is doubtful whether it will be possible for the League to maintain this neutral attitude much longer. A point seems to be now reached when the League may well declare the first branch of its work finished, and embark on a new career of first formulating a programme, and then endeavouring to obtain political support for the carrying out of that programme.

With regard to the question whether the present is an opportune time for taking the necessary steps to summon the conference recommended in the report of the committee, it must be remembered that arrangements will necessarily have to be made six, and possibly twelve, months in advance of the actual meeting, and it will always be a matter of conjecture how far any given time may be suitable for it. In the present state of English politics there is much to be said against calling the conference together at once, but it is difficult to believe that in one year, or even in two years' time, the public affairs of these islands will be in less of a turmoil than they are now, although the *casus belli* may not be same, for it requires no prophet to predict that English, Irish, Scotch, and Welsh politics will be in a disturbed state for some time to come. This seems, to my mind, to present an argument rather for than against the meeting of the conference at as early a date as possible.

To wait until an emergency arises is to banish calm judgment, and invite hasty and ill-considered action. A common enemy would, no doubt, call forth an amount of racial loyalty which would astonish, as well as edify, the world, and cause Britain's sons, all over the Empire, to stand back to back to fight the foe. But that would not be federation; it

would merely give us a further proof of what we know already, viz., the patriotic spirit of our kinsmen over the seas. When a Russian war was imminent the colonies volunteered help, and erected local fortifications, so proving that England could rely, in case of need, on the co-operation of the outlying portions of the Empire. But we know that, at that time, much money was uselessly and recklessly spent by colonial governments on defensive work, and that, under similar conditions, the same thing would probably happen again; whence it appears that, to secure the maximum of imperial defensive power with a minimum of waste, provision for a complete system of defence should be made at a time when the whole question can be calmly considered.

Whilst regretting that the proposal to immediately take steps to summon a Conference of the Empire does not meet with the approval of the British Government, I do not consider the committee of the League presented their case in a very forcible manner, or that on the report, as presented, the Government would have been justified in undertaking the responsibility of inviting the suggested conference.

Doubtless, the report is wide enough to cover the whole ground of Imperial Federation, viewed from almost any standpoint; but what was wanted was something of a more concrete and detailed character, which formulated practical proposals for dealing with existing conditions and removing existing obstacles and grievances. The report does not do this. It goes no further, in fact, than to suggest that the colonies should co-operate with the United Kingdom for the defence of the Empire, and in return be represented on what is styled a Council of Defence of the Empire. This question of giving the outlying empire representation is unquestionably the most difficult of all the problems that surround Imperial Federation, and I must be pardoned for stating that I consider the Council of Defence suggested is not such a form of representation as would prove acceptable to the colonies, or be of a very useful character. There is plenty of good practical work to be done by a conference, and if this practical work had been put prominently forward, as the primary reason for the conference, instead of being incidentally referred to as measures "conducive but not essential to federation," the case for the immediate summoning of a conference would have been stronger.

I will now mention some of the various questions which seem to indicate work large enough and important enough to engage the attention of many conferences.

1. The organisation of the military forces of the colonies, and the increase of the naval defences, especially in the outlying portions of the Empire.

2. Improved inter-imperial postal and cable communication by cheaper and more rapid services, providing, where possible, that communication shall be across British territory.

3. The determination of imperial as opposed to local services, and the best way of providing means for carrying on the former.

4. The consideration of the terms of British treaties with foreign powers in their bearing on colonial commerce, and the conditions on which self-governing colonies may carry on negotiations with each other and with foreign States for trade purposes.

5. The determination of the conditions under which the colonies may be permitted to control the introduction of aliens into their territories, and the inauguration of a plan of co-operation by the United Kingdom and the colonies for the encouragement and assistance of desirable emigrants from this country to the colonies.

6. The settlement of the terms upon which colonial inscribed stock may be sanctioned as a legal investment for trust funds.

7. The promotion of the necessary legislation to enable colonial governments to deal with unclaimed dividends on colonial loans, as in the case of the English funds and East India stock.

8. The fixing of a general standard of professional qualifications, so that they may be recognised all over the empire.

9. The abolition or reduction of the stamp-duty charged by the English Treasury on colonial public loans.

10. Uniformity in laws relating to marriage, divorce, and naturalisation, or, at least, uniformity of acceptance of the consequences of such laws.

11. The question of the extension of the Merchandise Marks Act to produce, and the best methods of checking the adulteration of food imported into the United Kingdom.

12. The assimilation of patent, copyright, and certain portions of bankruptcy and company law throughout the Empire.

13. The establishment of one system of coinage for the whole Empire.

14. The best means of promoting inter-

imperial trade, and the consideration of the customs tariffs of the Empire.

It is, of course, to be hoped that a conference would not entirely pass over the all-important subject of the political union of the Empire; but it is too much to hope that any very advanced progress would be made with this branch of the subject in any one conference, whereas the satisfactory settlement of some of the practical questions which are demanding settlement would lead up to and help on the cause of complete political union.

It seems a matter for regret that no steps were taken to invite the Governments of the various colonies to express an opinion on the expediency of the calling together of the conference prior to the requisition that was made to Mr. Gladstone, as any expression of opinion in favour of the conference would have considerably strengthened the hands of the deputation. But the silence of the colonies on the point must not be taken to indicate indifference. It has to be remembered that no Government of an individual colony feels called upon to take the initiative, or to act single-handed, and that the distance of the various self-governing colonies one from the other makes inter-colonial consultation impracticable. Even if a Colonial Council existed similar to the Federal Council of Australasia, the distances separating the various groups would make meetings so difficult as to be practically prohibitive. But I have often thought that if the representatives in London of the various colonies were to be constituted by their Governments into a Colonial Council, a means would be provided, not only for taking concerted action on colonial questions of common interest, but a useful and influential medium between this country and the collective colonies, would thereby be established. It is true that the High Commissioner for Canada and the Agents-General for the Colonies sometimes take concerted action, and frequently the Australasian Agents-General act together with satisfactory results, but this is probably owing more to the accident of the good *esprit de corps*, and friendly feeling existing among the Agents-General, than from any established rule that consultation and concerted action should be taken whenever practicable.

If a conference were called together for no other purpose than to inaugurate some system of colonial military defence which would secure that even the money now being expended by the colonies was spent in the right manner, that conference would not meet in vain. It is not so much the amount of money expended, as the way in which it is spent, and it is idle to say each colony can best arrange for its own defence; for, owing to the immunity from attack by foreign foes which the colonies have up to the present enjoyed, their people do not realise the necessity for systematic defence, and, moreover, they are too busy to think much about it. The organisation of a comprehensive scheme of defence is surely a question for the Empire as a whole, rather than for the component parts. I, for one, express a hope that the consideration of such momentous issues will not be postponed for any great length of time. Is Imperial Federation, national unity, or whatever people may choose to call the effort to cement together the scattered communities of the British people, commonly called the Empire, a mere question for debating societies and toy for idle men, or is it the one thing necessary for the salvation of the Empire?

Things may drift along for some time longer as they are, but for how long or how short a time no man knows, and delay is fraught with danger. There are indications already of the feeling of unrest in the colonies which Lord Salisbury aptly described as "an unwillingness to continually acquiesce precisely in the present state of things." The great colony of Canada is undoubtedly disturbed at the refusal of this country to give the colonies a preferential tariff, and many of her prominent men are coquetting with the United States to an alarming extent. The British taxpayers are beginning to cry out, without just reason as I have endeavoured to show later on, that their kinsmen in the colonies are just as well able to support the Imperial Navy as they are, and that it is unfair that the United Kingdom should pay almost all the money spent on a navy which is maintained as much in the protection of colonial as British trade and interests. The same argument is advanced with regard to some of the departments of State which are concerned with colonial questions, as well as with those affecting the United Kingdom.

On the other hand, people in the colonies feel that they cannot reasonably be asked to contribute further towards the cost of defence and administration when they have no power of controlling these services, and no voice in influencing the foreign policy of the empire. It is often pointed out, too, by colonials, that the Navy is the protector of British trade, and the guardian of a free water-

way for England's food supply, and that, should the colonies declare their independence to-morrow, the British Navy would have to be increased rather than decreased.

The British taxpayer, again, taking a wrong view of the position, does not relish the idea of being called upon to compensate British North-American fishermen in a matter which does not immediately concern him, especially when it is accompanied with the reflection that he may at any time find himself taxed to an alarming extent, to defray the cost of carrying on a war, brought about by a quarrel forced on the Empire by the action of a remote British colony. The British farmer is jealous of colonial farm products, imported into his own markets, and the British merchant dislikes a tax put upon his goods to encourage his colonial competitor. Colonials, on the other hand, are beginning to feel aggrieved that they should not have the power to make commercial and other treaties with each other and with foreign States when they choose to do it.

We find, again, that English trustees are precluded by law from investing the trust funds committed to their care in colonial stocks; that certain marriages, legal in the colonies, are not recognised here, thus branding the children of such marriages with the stigma of illegitimacy, and preventing succession on intestacy; that the English Treasury —whilst drawing immense revenues in the shape of income-tax on moneys received from the colonies—taxes colonial Governments on their loans and on their property held in England; that the ultimate Court of Appeal to the Privy Council is so slow in its results and so expensive in its application as to render it, in most cases, prohibitive; and that there is not only no colonial jurist on the Judicial Committee of the Privy Council, but, as far as I know, not one colonial representative on her Majesty's Privy Council in any capacity, an honour which would be much prized by colonial statesmen, and a distinction their services and position justify them in receiving. These points, considered singly, may not seem very important, and some of them may be easily answered, but matters which appear of little importance have often the largest influence, and, taken together, they are of sufficient moment to more than justify the demand that all parts of the Empire should be invited to lay bare their grievances in a common conference room. This is the only way to dispel imaginary grievances and to arrive at methods of satisfying real ones.

From what has gone before, it will be seen that I hold that the onus of taking action rests with the mother country, whether it be in summoning a conference, or in taking any other step which involves the joint action of Great Britain and the colonies. The matter at issue (the concord, expansion, and unity of the empire) is after all much more important for the United Kingdom than for the colonies. The interests of Great Britain in her over-sea possessions are enormous, and their loss means the loss of her prestige, and eventually the loss of a very large portion of her trade; and, further, a collapse in colonial credit, which would follow in the wake of dismemberment, and would bring about financial troubles unprecedented in England's history.

It is true there may be no immediate danger of disintegration, but if that disaster comes about it will probably come on the instant, and when it will not be easy to stop the rushing tide.

Notwithstanding that there is no immediate prospect of the meeting of an Imperial Conference, the present is a favourable opportunity to reflect on the work which it might perform. First, for the *personnel* of the conference. In the early part of the report one is led to believe that the suggestion made by the committee is to convoke an assembly similar to that held in 1887, and this was the request made by the League to Lord Salisbury in 1891, when he discouraged the proposal until there was a definite scheme to discuss. In the concluding paragraph of their report, however, the committee suggest the "summoning of representatives" of the United Kingdom, and of "the self-governing colonies." These words "of the United Kingdom," are the more remarkable as the whole tenour of the report leads up to the conclusion that the conference is to be on similar lines to the last, which was composed of colonial representatives only, presided over by the Secretary of State for the Colonies. The suggestion that representatives from all parts of the Empire should be invited alters the character of the proposal in a direction which should meet with general approval, and, therefore, is worthy of special emphasis. The conference of 1887 had no representative of the United Kingdom except in the person of the chairman. He, as a servant of the Crown, was there to listen and not to deliberate, and, although the success which was achieved was, in a great measure, owing to the tact and ability with which Lord Knutsford (the chairman)

regulated and guided the deliberations, there was no expression of English opinion; for, although the heads of departments and other officials who were interested in the discussions attended, they did not, and obviously, owing to the positions they held, could not claim to represent English public opinion. The conference now proposed would be a true national convention in which all parts of the Empire would be represented, due regard being had, I suppose, to each portion of the Empire having a degree of representation commensurate with its importance. Such a convention would naturally appoint its own chairman, arrange its own order paper, appoint its sectional committees, have power to summon witnesses and collect evidence, and present its report and recommendations to the Governments of the several colonies and the United Kingdom. The order of reference should be of the widest character, so as to leave the largest possible liberty. The place of meeting need not be London; indeed, much may be said in favour of its not being held in London, but, say, in Canada or the Cape instead. If it were held in London, the place of meeting, where all should feel at home and on terms of equality, is the Imperial Institute. Too much stress cannot be laid on the point that the conference must be imperial and not colonial, and that the representatives shall meet on an equal footing. As for a Parliamentary Royal Commission, to precede the conference, I see no need for it. The only thing wanted is the decision on the part of the English Government to invite the colonies to the conference, indicating the work to be done in terms sufficiently comprehensive to leave the representatives unfettered in the scope of their inquiry, and, of course, for the colonies to acquiesce. The conference itself is the Royal Commission, or it may be termed a committee of the whole Empire.

The reported proceedings of the last conference show a record of a large amount of most useful work; but there appears to be a want of what will be understood by the term committee work, for although papers and returns containing most valuable and pertinent information on various subjects were prepared for the information of the delegates, and the subject-matter discussed by them, in many instances the conclusions arrived at lacked details which would have been supplied by deliberation in committee. A marvellous amount of work was performed in an incredibly short time, and the results were practical and far-reaching. Any future conference would be able to take up many matters at the point where they were left off by the last, and to devote a considerable portion of their time to the necessary committee work. There might be sectional committees, such as the following:—Constitutional, defence, trade and commerce, finance, colonisation, inter-imperial communication. The setting up of committees composed of delegates specially selected for their capacity to deal with specific questions would enable a very large range of subjects to be dealt with in a way which the conference, as a whole, could never attempt. Various proposals have from time to time been made which, in the opinion of their advocates, are safe stepping-stones to a more complete consolidation of the empire. A Zollverein, a Kreigsverein, an Imperial Penny Post, and the rest, have each their advocates, but one and all seem to lead us on irresistibly to some form of representation in the national councils of the Empire, until the question of a complete system of political representation for the whole Empire stands in bold relief as the key-note of the position. The committee of the League have evidently felt this. In their report they lay down as the essentials of a united empire: —(*a*) That the voice of the Empire in peace, when dealing with foreign powers, shall be, as far as possible, the united voice of all its autonomous parts; and (*b*) that the defence of the Empire in war shall be the common defence of all its interests and of all its parts by the united forces and resources of all its members.

The committee call these propositions the essentials of a united empire, and certainly nothing less would constitute a basis for real union, but at the very outset they suggest the formation of some central body, in which all parts of the Empire may be represented. The old maxim "no taxation without representation" is so embedded in the English political system, that no proposal will satisfy a British community which does not recognise that principle. The Council of the Empire, suggested by the committee, does not, as I have said before, seem to me to meet the case at all; but the suggestion is a valuable evidence of the opinion the committee have formed, that the colonies are entitled to some representation. Such a council would practically have no control, and as for exercising a revising power over the defence estimates of the Empire, I fear such a body would be incompetent to deal with them.

The naval and military council contemplated in the report of Lord Hartington's Commission of Defence is a committee of experts which the proposed council could not be. As for the contention that members of the council would be available for consultation with the English Cabinet, every British citizen of the Empire is surely available for such a purpose at the present time. If the Secretary of State for Foreign Affairs wishes to consult with the High Commissioner of Canada over the Behring sea fisheries, or the Secretary of State for the Colonies to confer with any of the Australasian Agents General over the French *récidivistes* in the Pacific, or on any subject affecting the welfare of Australia, there is no difficulty in their so doing, or if the importance of the occasion warrant such a course, for these gentlemen to be invited to attend before a Cabinet meeting; and the mere fact of either of the gentlemen referred to being members of an Imperial Council for Defence would surely not lead to their being consulted more than they are now. Besides, the democratic feeling, which is stronger in the colonies than here, would be opposed to anything in the nature of what would be termed official representation. For my own part, I find it difficult to see how, when the time comes for the colonies to have a voice in matters of imperial, as distinct from local, concern, any half-measures can meet the case. It surely must come to the colonies sending representatives to an Imperial Parliament, if they are to have any voice at all. The time may not have arrived for that yet, and colonial representatives would be certainly out of place in the House of Commons as at present constituted, and it will always have to be clearly borne in mind that the colonies will not surrender the rights they now enjoy of managing, without interference, their own local affairs, even for the privilege of having some voice in imperial concerns. No scheme of federal union would find favour which in any way limited these rights.

The suggestion that the confederation of the Australian and South African provinces should precede the formation of the Imperial Council is, I fear, tantamount to shelving for an indefinite period the avowed purpose of giving the colonies some representation in imperial affairs, as it does not appear that there is any prospect of the Australasian colonies federating for some time to come, and the prospect of federation in South Africa is perhaps more remote still. That Australian federation will come in time there is little doubt, but too much importance must not be attached to abstract resolutions passed by local parliaments in Australia, and until the strong man arises, whose personality and ability are sufficiently conspicuous to overshadow local and individual jealousies, the movement will probably make small progress. The colony of New Zealand, being 1,200 miles from the Australian continent, has so far shown small inclination to join a confederation which might not make due provision for her isolated position and different interests. The attendance of the leading men of the Australasian colonies at an Imperial conference, at which matters affecting the Empire as a whole would be discussed, would have a powerful influence in destroying local feeling, and bringing home to the minds of the Australian people the advantages of an Australian confederation, and the absurdity of one people, possessing the same laws and occupying one continuous territory, snarling at each other, instead of joining hands to develop a continent which possesses within itself all the essentials of a mighty empire.

Hitherto the Imperial Federation League have selected co-operation for defence as the first and safest step towards the fulfilment of their programme, and few of the prominent members of the League have cared to commit themselves to anything very definite beyond this. To say that each portion of the Empire should contribute towards the cost of defending interests which are common to all alike is to enunciate a safe policy, and the people of the Australasian colonies have already given a practical adhesion to it, in defraying the cost of maintaining war-ships specially provided to conserve the joint interests of the Australasian colonies and the United Kingdom. The prompt response of the Australasian colonies to the invitation for co-operation in naval defence is no doubt a practical proof of their patriotic spirit; but I believe the motives which urged the colonies to acquiesce in this proposal were prompted by a feeling that a refusal to respond to the invitation would have raised a doubt in the minds of the British people as to the loyalty of the colonies, and by a belief that the presence of a British fleet in colonial waters, in which part-ownership could be claimed by the colonies, was invaluable, as a means of keeping alive and fostering the sentiment of race-unity, rather than by an acknowledgment that the proposal was one which was based on sound principles

Although I have always considered that the

present provision for the military and naval defence of the over-sea colonies is inadequate, and although I recognise that defence is a duty which devolves on the Empire as a whole, I have always maintained that defence is only one out of many joint obligations, and that it is an imperfect method of dealing with the subject to select defence and ignore the others.

The whole drift of the report of the committee seems to be in amplification of the English view, that the colonies do not pay their fair share of defence, and should be invited to do so, in contradistinction to the opinion, which I believe to be strongly held in the colonies, that they already perform more than their fair share of imperial obligations, and that, if they are to be asked to do more in this respect, the request must be accompanied with some form of colonial control over the expenditure. If this is to be assured by colonial representation in a national council, it must be representation which does not limit the local autonomy of the colonies, and which, so far as matters of imperial moment are concerned, places them on terms of equality with the parent land.

Before Imperial Federation can advance further, some clear line of demarcation must be drawn between these local and imperial burdens, and in doing this the colonies should be regarded not as communities intending to set up for themselves when they are sufficiently developed to do so, but as integral portions of the Empire, ready to permanently remain members of the firm of Great Britain and Company, and to assume the full responsibility of partnership. If public men would consider the Empire as a whole, and regard in a less degree the momentary interests of that small portion of it which is their immediate concern, a different order of things would ensue. Probably this is asking too much, and just as the local country election frequently turns on the vital issue of whether a candidate purchases his goods from the Army and Navy Stores in London, instead of from the local tradesmen, so, doubtless, comparatively unimportant considerations will continue to make it difficult for a statesman to look farther than his immediate surroundings. The consideration of the Empire as a whole is a very large and diversified subject, no doubt, yet that is the tangled skein that we have to unravel before we can weave the different portions of it into a symmetrical whole.

Some of the questions of imperial as opposed to local concern, which, I think, are not sufficiently considered, and which are of an importance equal, and, in some ways, superior to defence, are those directly concerned with the colonisation or development of the outlying portions of the Empire; for, given a fuller expansion of Greater Britain, the Empire would be a power no foreign country would dare to attack. The colonies have been allowed to work out their own destiny with very little aid from the Imperial Parliament. This has certainly helped to make them self-reliant; but, taking a review of the last half-century, I do not think the progress made in Canada, Australasia, and the Cape, very creditable to British statesmen, especially when we look at that made by the United States in the same period of time. The United Kingdom has allowed the cream of her population and her gold to be poured into the United States and other foreign lands, when a very small effort and expenditure would have directed them to her own colonies. If only her emigrants, during the last half century, had gone to the colonies instead of to the United States, we should have seen to-day these groups of colonies possessing a total population of at least 25,000,000, instead of, say, 10,000,000, and consuming more than double the present colonial consumption of British goods. What that would have meant for the workers of the United Kingdom is hardly realised. The 10,000,000 of people in the self-governing colonies mentioned, buy more British goods to-day than do the 70,000,000 representing the population of the United States, and more even than do the 250,000,000 of British India, and an increased population in the colonies means a permanently increased and increasing trade for the people of the United Kingdom with its attendant advantages. It is true that during the past 50 years the progress of the colonies I have named has been steady, and the colonials who have achieved the success can point to their record with pride. The honour, however, rests with them more than with this country. By enterprise, hard work, and self-denial they have developed their estate unaided. When I say unaided, I admit that without English capital their progress would have been small; but the capital has been provided for them by individuals seeking for a high return of interest, and the State has done nothing, or very little towards it. In order to carry on the work of colonisation, a work directly and immediately beneficial to British trade, colonial governments have been obliged to contract enormous debts, and to pay a very high

rate of interest for the necessary accommodation. The English Treasury has taxed each colony on every pound it raised in England, the London money rings have had a liberal slice of each loan in the shape of brokerage commissions and the like, the English merchants have retained the rest, and a good deal more besides for goods despatched to the colonies, and the colonial taxpayer has had to incur permanent obligations to pay, not only the interest for the English money-lender, but an additional sum for the income-tax he has to provide for the English Treasury, which derives a very large annual revenue from the colonies. The Treasury has absorbed, in round figures, £1,000,000 in the shape of stamp-duty on colonial loans, and every year receives into its coffers £500,000 at least in the shape of income-tax, levied on incomes derived from the colonies. Even the representatives of the colonies in London are taxed on their official salaries paid by the colonial governments, although foreign ambassadors escape the tax. The estimate of £500,000 is certainly within the mark, for £20,000,000 per annum is not too much at which to estimate the annual receipts in the shape of income from colonial investments and trade, and sixpence in the pound on that sum produces the annual sum I have named. I mention these matters in order to emphasise my point, that the United Kingdom has not only contributed very little towards the development of the colonies, but derives a considerable revenue by taxing them. Are not they, therefore, justified in asking that this fact should be taken into account when determining what share they bear of imperial burdens? The colonies are, if anything, too free with their money, and cannot, with justice, be charged with parsimony; but they owe a first duty to their English creditors. The annual interest must be provided, and nothing can be permitted to interfere with the fulfilment of this obligation. It may be justifiable to increase this annual interest-charge by fresh borrowing for further development, as this increases the security for the public debt, but the increase of annual charges for unproductive works must be very jealously guarded, and, if the colonies are to be asked to make any further contributions towards imperial services, it must first be demonstrated that the demand is a just one.

It is the over-eagerness of some of the Australian colonies to carry on this very work of colonisation that has temporarily crippled their finances. This country will suffer equally with Australia in the necessary shortening of expenditure, pending the rehabilitation of Australian credit, and the great work of colonisation in Australia will receive a serious check. Surely, even as an investment, it would pay over and over again to spare something every year out of a £90,000,000 budget in promoting settlement of the surplus population of these islands in the colonies. Even as a business proposal this is sound. Every colonist consumes annually British manufactured goods to the value of about £4, against a corresponding equivalent of about 15s. by a citizen of the United States. What is it worth to secure customers to the extent of £4 a year for British goods, who, instead of ceasing to buy at any given period, will increase and multiply in geometrical ratio? I admit the question is not free from difficulty. The colonies are determined not to open their doors to settlers who may become a burden as soon as they are landed, and the United Kingdom is averse to encouraging her best people to leave her shores; but, on the other hand, the colonies are anxious and willing to receive settlers who are suited to their requirements, and an understanding could be easily arrived at which would be the means, not only of furthering the work of colonisation, but also of retaining permanently as British subjects and consumers of British manufactures, the thousands of emigrants who leave these shores every year.

The popular idea in England that the whole burden of the defence of the Empire is borne by taxpayers of the United Kingdom alone or almost entirely so is not correct, the colonies having done much more for defence than is credited to them. During the last Colonial Conference, held six years ago, the following summary was prepared by Sir Francis Dillon Bell, showing, as nearly as he could arrive at the figures, the amounts expended by the Australasian colonies up to the year 1887, upon defence:—

	£
1. New Zealand	7,152,938
2. New South Wales	1,917,896
3. Victoria	4,057,978
4. South Australia	515,694
5. Queensland	490,169
6. Tasmania (round numbers)	80,000
7. Western Australia	16,470
Total	14,231,145

The amount is a considerable one, and Canada and the Cape have been left out of the calculation. I have not been able to obtain the

ross figures for these two groups of colonies; it I find that Canada alone has made the llowing provision for defence for the current ear:—

1. Militia	$1,256,382
2. Department of Militia	45,462
3. Expenditure on Steamers, Marine and Fisheries Department.	122,400
4. Lighthouse and Coast Service	534,110
5. North-West Mounted Police	625,000
	$2,583,354

But a very much larger sum has been xpended by the colonies on works which, lthough not generally classed as defensive orks, are absolutely necessary in any system f imperial defence. Coal mines have been pened out, harbours constructed, railways, hich may be of immense importance for the ansport of troops, have been made; lighthouses erected along the coasts, roads and elegraphs made, not to mention others, which re all adjuncts to a complete system of efence, and which have been constructed at very large cost to the colonies.

Inter-imperial communication is another service which should devolve on the Empire as a whole. It will be found that the colonies have ncurred a very much larger expenditure in roportion to their population than have the eople of this country, to maintain services rom which British trade derives a very large nd, indeed, the chief benefit. An example vill illustrate my meaning. The best mail ervice from England to New Zealand is that cross America and the Pacific. That is the ervice chiefly used by the commercial classes is it is reliable and a week shorter in delivery, effecting, thereby, a considerable saving on he interest on money drafts sent to and from he colony. Yet because there is another service *viâ* Suez (unreliable though it be as far as New Zealand is concerned) the General Post-office regards the San Francisco Service as a luxury, and refuses to pay the full cost of the carriage of the English mail to the colony, although the latter defrays the entire cost of the homeward mail, thus compelling New Zealand to abandon her only efficient service, or pay a portion of the expense of carrying the English mail, in addition to the entire cost of carrying the colonial mail. Again, the cable service to Australasia has, in the interests of improved communication, been cheapened under a system of joint guarantee by the colonies concerned, and the Eastern Telegraph Company. The British people profit by the reduced rates, but they do not join in the guarantee or contribute towards the loss. There can be nothing more calculated to promote the cause of imperial unity than more frequent, cheap, and rapid means of communication between the various portions of the Empire; but even on this head the United Kingdom allows her colonies to outdo her. These may be small matters in themselves, but an important principle is involved, and I feel assured that when the account of imperial burdens as opposed to local is made out, the colonies, instead of being debtors to the parent land, will be found to have a large credit balance in their favour.

The money expended by colonial governments is surely as beneficial to the empire as a whole as is the money spent by Great Britain over a British work—indeed, going a step further, I maintain that the people of this country have benefited much more from colonial borrowing than have the colonists themselves. I have always regarded colonial governments much in the light of agents or trustees for the Empire, spending English capital for the mutual benefit of the country that lends as well as the country that borrows, and in a limited sense I look on the assets of the colonies as part of the property, and their indebtedness as part of the obligations of the Empire. I am quite prepared to learn that my view is not indulged in by many people, and the present is not the most favourable time to expound such opinions, but, as a basis for federating the Empire, I believe the consolidation of the national debts, or at least such portions of them as have been incurred in providing works of an imperial character, is one which would be practical and attractive, and which would present fewer difficulties than any other proposal which has yet been made. If the rate of interest, payable by the colonies on their public debts, was reduced to even 3 per cent., an annual saving of several millions a year would be effected, and the money saved could be expended on what might be determined to be imperial services, such as defence, colonisation, public works, cheaper means of communication, and the like. An enormous impetus would be thereby given to colonial credit and property, and while the liability of the United Kingdom would be merely nominal, the advantages to the Empire would be immeasurable. This country would not hesitate to spend two or three hundred millions on a war in defence of her colonies; and why should she hesitate to assume a

liability which would be one in name only, but which would immediately cause British prestige, trade, and influence to bound forward with new life and vigour? The necessity for future borrowing by the colonies would be minimised, and, of necessity, regulated, as a condition of such a scheme. Perhaps, for this very reason, the proposal would not find favour in some of the colonies.

Short, however, of consolidation of the national debts of the Empire, there is, I believe, much to be done by the colonies in the way of improved methods of finance in London. One of the present evils in connection with the subject of colonial public debts is that, when loans have to be renewed or a fresh loan obtained, the colonies are at the complete mercy of the English money-lender, and have either to propitiate the market or incur a great risk of failure. This is ruinous finance; and it is time the colonial governments took the matter into consideration, with the object of taking joint action in making an endeavour to extricate themselves from their present position of financial slavery. Even if Canada and the Cape stood out of such an arrangement, I believe it would be possible, stopping short of joint and several liability, for the Australasian colonies to make a compact with certain banking institutions in London which would not only effect a considerable annual saving in the management of their public debts in England, but would also enable a business arrangement to be made sufficiently strong to ensure redemption loans being taken up whenever necessary, and new loans placed on the market more favourably than at present. My own colony is in the happy position of being just now on velvet in the matter of public finance. New Zealand is now more prosperous than at any time in her history, and the rapidity with which fresh country is being settled and brought into production is a safe augury of greater progress still. She has every year, for the last five years, shown a surplus of revenue over expenditure, and has recently closed the financial year with the largest surplus on record, while the cable brings us news that the Government do not propose to borrow further in London for two years at least. This happy state of things is owing, no doubt, in the first instance, to economy, and the large growth of settlement, and the consequent increase of exports; but in no small degree is it also owing to the fact that financial operations in London are rendered easy and profitable because the colony holds in reserve here, securities (guaranteed by th Imperial Government), which could be sol in the open market, at any time, for litt short of £1,000,000 sterling. This nes egg is seldom used, but its existenc establishes such a strong position, tha other colonies would do well to provide similar reserve. Any colony doing so woul be recouped over and over again, as Ne Zealand has been, by the great saving effected through her being in a position t dictate terms, instead of being in the too common condition of a suppliant for Englis money. This may be considered outside m subject, but I have touched upon it as show ing that a meeting of colonial delegates at a imperial conference would afford opportunitie for discussing and settling questions whic are, possibly, more of colonial than imperia concern, but in the discussion and arrangin of which the experience and influence of som of the English representatives would b of the greatest value. It is asking ver little to request the Government and financia institutions of the mother country to enabl the colonies to carry on their work, whic is of such benefit to the whole Empire under conditions as favourable as they ca possibly be made, instead of, as now, whe the English Treasury, the financial institu tions, and the speculator, all in their turn make out of the unfortunate colonies more tha can be called fair profits.

My paper is already longer then I intende to make it. Many points that I should like t have gone into more fully I have been oblige merely to touch upon, and the few opinion and criticisms I have offered are tendered wit the hope that others more able and fitted tha I am for the task will pursue the subjec further. I have endeavoured to show tha the present condition of the self-governing colonies is not satisfactory either to the colonies or to the mother country, and tha owing to the difficulty of inter-colonial consul tation and agreement, the first step in any movement to more closely consolidate the Empire must originate with the United Kingdom. What that step is to be is for the statesmen of this country to determine; but, I feel assured that, at the present time, a ready reponse would be given by the self-governing colonies to any proposals made for a closer union with the "old country." Believing, as I do, that there is work of a practical and pressing character to be done by a conference, I regret that preparations for summoning one are

not being undertaken; but a reasonable delay may be turned to profitable account, by the opportunity presented for formulating definite proposals to be submitted to the consideration of the conference, and for obtaining an expression of colonial opinion on the expediency of holding it.

The most gratifying aspect of the whole subject of Imperial Federation is the earnest manner in which statesmen and writers, both here and in the colonies, are now addressing themselves to all questions bearing upon the future relations of the different portions of the Empire; and we must only hope that before long some practical and business-like proposal will be forthcoming, which, while keeping intact British sentiment and patriotism, will, at the same time, present practical advantages sufficiently enticing to bring about the closer union we all desire.

DISCUSSION.

Sir FREDERICK YOUNG, K.C.M.G., said that having taken, for many years, a somewhat prominent position with regard to this very great national question, he might perhaps be permitted to occupy the time of the meeting for a few moments while he alluded very briefly to some of the points that had been brought before them by Mr. Perceval in so lucid, masterly, and comprehensive a manner. He had been exceedingly delighted with the general tone of the sentiments Mr. Perceval had expressed, as they so entirely coincided with the views he had put forward many years ago, and he was very glad indeed to find himself in so perfect accord with the general principles enunciated in the paper. Mr. Perceval had prefaced his observations by saying that he felt that, in no circumstances, ought the British Empire to be disintegrated; but the great point was to discover how the permanent unity of the Empire might take place. That could only be by a system of what they were pleased to call Imperial Federation. The whole gist of the question was the representation of the colonies, with power, and an adequate contribution to the imperial objects which were required to maintain the Empire. Mr. Perceval had criticised very minutely, and with considerable acumen, an important report which had recently been placed before the public by the Imperial Federation League. He (Sir Frederick) did not altogether agree with many of the points in that report, but he felt it was one that ought to be supported unanimously by the League. He, therefore, seconded the motion for its being accepted as a valuable document put forward by the League. Deputations had waited upon the Premier and the ex-Premier, asking for another conference to be held in this country, and Lord Salisbury said that no apology was necessary for coming before him, as the question brought to his notice was no less than the future of the Empire. When they went with a similar request to Mr. Gladstone, he answered the appeal that was made to him sympathetically, but declined to grant a conference, considering the present was not a fitting occasion. He (Sir Frederick) was sorry to see that Mr. Perceval did not agree with him in a proposal which he ventured to put before the public some time ago, and which he should continue to press forward with all his might and energy, and that was a Royal Commission. If the mountain would not come to Mahomet, Mahomet must go to the mountain; and two Prime Ministers having declined to call another conference, the mother country should have a Royal Commission to go round the colonies and to interview the very men who would have been invited to this country had the proposal to convene a conference been acquiesced in They would thus have obtained a mass of valuable representative colonial opinion upon every subject connected with the question, which would be invaluable for future legislation. Although the general public would not be aware of what had taken place until the evidence was made public, their interest would be kept alive by the means referred to. He had been very much struck with the comprehensive list of questions which Mr. Perceval suggested should form the basis of any future conference. Every question was of a most valuable character, and this was one reason why he did not altogether concur with the committee of the Imperial Federation League which drew up the report, as they confined themselves almost entirely to the question of defence, when Imperial Federation meant a good deal more. He took a comprehensive view of imperial matters. One of the cardinal questions must be a thorough representation of the colonies. They must expand the old British Parliament, and suit it to the necessities of the latter part of the 19th century. Grand as the subject of Imperial Federation was to his mind, it was really contained in a nutshell, namely, thorough representation of all the colonies, with the mother country, in due proportion, without interfering with local autonomy.

Sir EDWARD BRADDON, K.C.M.G., expressed his very deep sense of the advantage conferred upon the Imperial Federation movement by the very able paper which had been read that evening. He was sure that every lover of and believer in Imperial Federation would agree that the paper would have been a splendid contribution to the literature of the cause, whoever might have written it, but it was still more valuable as coming from a gentleman who by birthright was empowered to speak on behalf of one of the colonies. Mr. Perceval, in referring to the loyalty of the colonies to the imperial union, spoke with an authority greater than that of any one who was a colonial by adoption only. We who desired to see a closer union brought about between the outlying portions of the mother country and the mother country itself must be very

glad that a writer so able and outspoken had applied the spur to those who were moving in that direction. No doubt the Imperial Federation League had done great service in keeping up the sentiment of closer union; and they had swept away some delusions which had enveloped the subject, their own scheme not excepted. For instance, they had adopted the idea that it was for the mother country to make some proposal for a closer federation to the colonies, and not for the colonies to make such proposal to the mother country. That idea was at one time largely entertained—an idea that would have found great favour in Laputa; but it was not a practical idea; for, as regarded a union such as was desired, it surely behoved the senior partner to appeal to the junior, rather than the reverse. Mr. Perceval had hinted very broadly that what he desired to see in the shape of Imperial Federation was complete representation. Surely, in these latter days, they had had reason given to them to believe that such representation as would effect this union, the representation of the colonies in the Imperial Parliament, was, at any rate, not a sheer impossibility. It was proposed to give autonomy to Ireland, and at the same time to retain Irish members in the Imperial Parliament. Autonomy had been given to the colonies, and, by parity of reasoning, it was quite feasible to give the colonies representation in Parliament side by side with the Irishman, and no doubt there would be some advantage in having that balancing power there. He admitted that this was a very great question, surrounded by many difficulties, but the difficulties were capable of being surmounted, and it would be the business of such a conference as was suggested to sweep away the difficulties so as to effect the proposed object. He considered that the contribution now provided by the colonies was as large as Great Britain could expect them to pay. The spur had been given to those who were moving in the forward direction which Mr. Perceval desired to see taken; and all those who desired to maintain this splendid empire would necessarily hope that that meeting, with the ventilation of the matter consequent upon it, might show, in the course of a very short time, that there was to be such action as would make the united empire of Great Britain the envy and admiration of the world.

Mr. H. Moncrieff Paul had hoped that Mr. Perceval would have shown a little more the efficacy of half a loaf being better than no bread, and that colonial federation, in certain groups of colonies, might have preceded Imperial Federation; so that, working from the smaller, they might gradually reach the greater, and have, ultimately, what they all desired to see, Imperial Federation in full. Mr. Perceval had alluded to the ignorance in this country about the colonies. To a certain extent, this was true, but, speaking as a colonist, he thought they must bear in mind that, when colonists came to London, they were apt to think that they were entitled to recognition quite beyond their merit When they saw colonial matters treated in th London Press somewhat scantily, they forgot tha the Press of London had to deal, not only with th colonies of Great Britain, but with other lands This so-called ignorance was now gradually disappearing. Mr. Perceval had rightly pointed to the Roya Colonial Institute as one great means by whic knowledge of the colonies had been disseminate throughout the mother country. He agreed wit Sir Frederick Young that the list of subjects whic Mr. Perceval thought well fitted to demand th attention of a conference on federation was a ver just and comprehensive one. But he shoul have liked to have seen fiscal union No. 1 instea of No. 14, because he thought the first step toward federation was fiscal union. He lamented the fact tha South Australia could not send wine to New Zealand and New Zealand oats to South Australia, withou paying duty. It was an absurdity that a man going fron Victoria to New South Wales should have to underg the ordeal of search on crossing the Murray; and tha the stock of New South Wales sent into Victori for sale should have a tax put upon it, that tax bein only remitted when it was proved that the animal were to be slaughtered for refrigerative purposes and exported to this country. Mr. Perceval had hi the nail on the head in his remarks with regard t military and naval defence; that had been put forward as the one point, in federation, instead o being only one of many factors. Improved telegraph and postal communication could not be to much insisted upon. The Suez route was naturall the best route for the Australian Colonies, th advantage of the San Francisco route being confine to New Zealand; but he hoped the day was not fa distant when, by means of the Canadian Pacific route they would have throughout, not British soil, but th northern British Colonies, a means of communicatin with our southern possessions to very great advantage. Steps were already being taken in this direction. The question of making investments o money in Colonial Inscribed Stock, had received considerable attention, but the present was not a happy moment to enforce this. If trustees had now large amounts in Inscribed Stock they might get into a good deal of trouble with their principals in being asked to sell out, however mistaken the advice might be. With regard to immigration, and the comparison made between the United States and the Australasian colonies, he thought Mr. Perceva had overlooked one or two points. In the first place, the greater distance of the Australasian Colonies as compared with the United States was a very marked one; people could go to the United States much more cheaply than they could go to the colonies. On the other hand, it was manifest that a great deal more might be done by the mother country, and by the colonies themselves, to induce suitable immigration. When the working man came strongly into power his desire was not to foster immigration, but

ther to prevent it. Two great factors towards the :velopment of a new country were to increase e population by immigration, and to develop the ıtural resources by the importation of capital. 'ith regard to the taxation of colonists in this untry, he thought there was a little misapprehen- ɔn upon the part of Mr. Perceval; if people in ngland invested in colonial stocks, and paid income- x, that tax was not a charge against the colonies, ıy more than it could be said to be a charge against rench, Spanish, Russian, or Italian Stocks. If a ılonist came to England and settled, and was ıarged income-tax, that was a tax placed upon him r the privilege of living in the mother country. he recasting of colonial finance was a very ıportant question, and one that would require be taken up sooner or later. The loans of ıe various colonies were of such a nondescript ıaracter that there was great loss in their adminis- ation. It would be very much better that each ılony should have its loans consolidated, or, if that as not practicable, that each colony should find ıt the rate of interest at which it could borrow to lvantage, and that the loans should be consolidated :cordingly. The difficulty seemed to be that ılonists wanted to get too high a price for their ans; in other words, they were not prepared to ıy a discount on par value at the rate of interest ıey chose to take. They forget that it was very much ɛtter that a loan should be issued at a discount, so ıat, with improved credit, it might rise to par, ıstead of being issued at par and rising to a great remium. The premium so acquired was, to a certain ctent fallacious, because when the principal money as paid off it was paid off only at par, and the ıvestor had to make a difficult calculation to know cactly what return he would eventually receive. Vhile there was no fear of repudiation on the part f the Australasian colonies in the payment of annual ıterest, one important feature in colonial borrowing ıould not be lost sight of. A good deal of the ıoney borrowed was spent in the formation of rail- ays too often constructed not for traffic, but for ıe purpose of increasing the value of the lands ırough which they passed. Lavish borrowing was n economic error, and an apt illustration of this roposition was at hand in the case of New Zealand, hich was now making more substantial progress ıan in the days when, under a system of debt iling, she was believed to be progressing by leaps nd bounds.

Mr. J. G. RHODES welcomed very much the ıggestion of a travelling commission. The last ɔeaker attributed the unsatisfactory position of ıe public debts of the colonies to the fact ıat their loans were badly set on issue, that is to say ıey were issued to bring par value instead of being :t at a discount, the rate of interest being put high ıstead of low. That was unsound finance no doubt, ut he attributed the unsatisfactory condition of the loans more to the use to which the money was put when borrowed. The colonies wanted information as to the general and better administration of public money in England. The principle in Australia seemed to be to borrow money, and to spend it usefully if it could be so spent, if not, at any rate to spend it. Nothing could possibly be more unsound. You had only to do that sufficiently long to bring credit into a most abject condition. That was a point which might be incidentally dealt with by a Commission, as they could show, in a judicial spirit, to colonial financiers, the error of the course they were pursuing, and the soundness of the course pursued in England. In England they waited till there was an absolute necessity for spending money before proceeding to borrow it. Another point was one connected with free-trade, as opposed to fair-trade. He spoke from the point of view of a thorough free-trader. If the colonies could be shown, by a process of definite reasoning, and clear cause and effect, that it was impossible for this country to depart from its fiscal position, which it had occupied since free-trade became its adopted custom, a great step would be made in clearing away difficulties, because these difficulties were supposed by many of the colonists to be difficulties which could be talked away and got over in their interest. The sooner colonists understood that that was an impossibility, the sooner they would get at a basis for considering the view of federation.

Mr. ROBERT NIVEN thought that Mr. Perceval was right in thinking the time had come for formulating a definite scheme, and that they ought not to delay the calling of the congress. As the colonies could not do without the help of England in the matter of defence, he did not see why they should not pay their proper share towards it. Mr. Perceval had referred to the loss which the colonial system had sustained by such an enormous number of the population going to America; but had proper facilities been held out by the colonies to the better class of population, he thought the colonies might have obtained large numbers who went to the United States. The working classes in the colonies did not wish a greater number of working men to be introduced, because they knew that, if they were, wages would be reduced. The patriotic feeling of the working classes was not sufficiently appealed to. He considered it was in the interest of the peace of the world that the colonies should be drawn closer together. If this were done, the Empire would be so strong that, in the course of 50 or 60 years, they would be able to say to other nations that they must not go to war without trying arbitration; that if they did, the aggressors would have the whole British Empire against them.

Mr. WALTER SMARTT said that the more distinct the Australian colonies were made from England the greater, he considered, would be their progress.

Everything should be done to encourage trade with the Australian colonies, and to induce them to combine and form one strong federation.

The CHAIRMAN, in proposing a vote of thanks to Mr. Perceval for his valuable contribution to the literature on the subject of Imperial Federation, said that the question was one on which almost every person had his own ideas, and people regarded it from different standpoints. Some looked upon it as within the range of immediate politics, some entertained it as a pious opinion, and others regarded it as a fad and chimera, as a thing which could never be realised. Before he went to Australasia, he found the idea prevalent in the minds of statesmen at home that the initiative towards any federation must be taken by the colonists. If such a step were suggested by the Imperial Government, it was thought that a cry would arise in the colonies that we were endeavouring to dictate to them, and, therefore, this matter was excluded from the Conference of 1887. Now, he found the statesman with whom he had come in contact in Australasia were all calling upon the mother country to take the first step. This reminded him somewhat of the attitude assumed by two captains of the British forces in the early part of the century, of whom it was said—

> " Lord Chatham, with his sword undrawn,
> Stood waiting for Sir Richard Strachan ;
> Sir Richard, eager to get at 'em,
> Stood waiting—but for what ?—Lord Chatham."

When the deputation that had been referred to waited upon Lord Salisbury, some eighteen months ago, he described the consummation of Imperial Federation as a subject for hard thinking and for close examination. The appeal he made upon that occasion had not been made in vain, as they saw from signs upon all sides. They found the heir to the throne had adhered to the proposal which he initiated in the Jubilee year, and had carried it successfully to its completion by the opening of the Imperial Institute; and they found that one of the most eminent members of the present Government, Lord Rosebery, had allied himself in the closest possible manner with Imperial Federation. The question had now received attention at the hands of the Agents-General for the colonies, and it had many points to commend it to public attention. Although that portion of the British public which had taken the matter up was a small one, it was influential. The great mass of the people had not yet been induced to take a very active interest in Imperial Federation, nor had they been called upon to make any sacrifice ; but then it must not be forgotten that the question had never been placed before the electors of the country. He was sufficiently sanguine to believe that whenever the day came that the people were called upon to make some sacrifice for the preservation of the unity of the Empire, they would not be found wanting. Mr. Perceval was at one with those who had approved of the recent action of the Imperia[l] Federation League, and who desired that anothe[r] colonial conference might be summoned at an earl[y] date. He agreed that there were a number of subjects which were now ripe for discussion by such a conference, but it was not clear whether it was necessary or desirable that they should first ask the Colonial Governments whether they were anxious to enter upon discussions similar to those of 1887. It would be better he thought, to formulate the propositions, and to ask the colonies to send over distinguished representatives to discuss them. They naturally expected on a question of this kind that the colonies would send the best statesmen they possessed, but in asking for this they were asking for some considerable sacrifice. He was not quite sure whether Mr. Perceval had rightly interpreted the views of those who summoned the Conference of 1887. They felt that in asking the Colonial representatives to come here, they were asking them to discuss matters with the representatives of the people of England. Every question discussed at that conference was a question which required some concession on the part of the Imperial Government, and, therefore, it was essential that it should be discussed in London, where the ministers and heads of all departments could be consulted. He could hardly conceive that such happy results as arose from the Conference of 1887 could possibly have been obtained anywhere else than in London. With regard to sending round a travelling commission, as suggested by Mr. Rhodes, he did not think it would serve any useful purpose, nor did he think the English system of finance was quite so perfect as that gentleman would have them believe. He hoped the day was not far distant when Imperial Federation would come within the range of practical politics, and be discussed between representatives of this country and representatives of the colonies; and he was sure that with the careful thought which Mr. Perceval had bestowed upon the question, he must take an important and leading part in it.

The vote of thanks having been carried unanimously,

Mr. PERCEVAL said that, although there was a strong desire to draw the bonds of union closer, the many difficulties surrounding the subject would possibly prevent the necessary steps being taken. The danger he foresaw was that the question would be put off until it was somewhat too late. That was why he joined with those who wished the conference to take place at an early date. Undoubtedly there was a vast amount of practical work for a conference to do, and it was all work which led up to a closer union. The question of political representation was the most difficult of all the questions which had to be considered. That might be the goal that many were aiming at, but they must be prepared to work up to it step by step.

Miscellaneous.

THE CHICAGO EXHIBITION.

In describing the present condition of the Exhi-
›n the *Times* correspondent at Chicago writes:—
There are over 150 buildings of all kinds on the ounds, and all the greater buildings were long since ıished, although final touches of painting and ·coration are still being given to some of them. ıey are by far the finest collection of structures ever ıilt for a World's Fair, and include some of the andest ever erected. The larger structures, which all united in one building would cover 130 acres, e the following, their dimensions being given in feet, th the floor and gallery space for exhibitors esti-ated in acres, and the cost of each:—

Buildings.	Dimensions.	Space.	Cost.
			£
ıministration	262 by 262	4·5	92,643
anufactures	1,687 ,, 787	44	345,486
achinery	842 ,, 494	17	
,, Annex	551 ,, 490	6·2	234,779
,, Boiler-house	1,103 ,, 86	2·2	
griculture	800 ,, 500	15	131,737
,, Annex	550 ,, 312	4	
ectricity	690 ,, 345	9·3	84,670
ining	700 ,, 350	8·5	53,306
·ansportation	960 ,, 256	9·4	96,636
,, Annex	850 ,, 435	8·5	
orticultural	998 ,, 251	8	59,730
sheries	361 ,, 162	1·4	43,534
,, Two Annexes	135 diameter	·7	
ne Arts	500 by 320	4·6	147,562
,, Two Annexes	220 ,, 136	1·4	
·omen's	398 ,, 199	3·3	27,080
nited States	421 ,, 351	5·5	80,000
,, Battleship	348 ,, 69	6	20,000
inois	450 ,, 160	5	50,000
›restry	528 ,, 208	2·6	16,404
ıilway Station	300 ,, 150	4	45,077
,, Train Shed	672 ,, 150		
ıiry	200 ,, 94	·8	5,862
·ather	625 ,, 150	4·3	17,888
ve Stock	440 ,, 260	2·5	12,452
.w-mill	300 ,, 136	1	4,359
usic-hall	246 ,, 140	·7	
ısino	246 ,, 140	·7	73,251
·ristyle	600 ,, 60	·9	
er and breakwater	2,500 ,, 250	11·5	64,313
ırt Institute (in Chicago)..	—	—	40,000
ıoral-hall	—	—	17,349
ıthropological	—	—	17,133
rvice offices, &c.	—	—	42,057
ıildren's	—	—	4,443
onastery La Rabita	—	—	5,861
ıcking-case storehouse	—	—	7,173

ſntended for public meetings in connection with the Fair.

Besides stating these figures, I will also quote the llowing, showing some of the chief items of ex-nditure outside of the buildings:—

Pumping works for water supply	£47,347
Constructing lagoons and harbour	157,560
Constructing roads and walks	£66,484
Constructing bridges	17,178
Constructing railways	85,915
Constructing fire and police-stations, &c.	54,436
Grand fountains	24,500
Water pipe and sewerage	92,121
Statues and sculpture	34,392
Electric plant	148,397
Boilers and machinery	72,758
Decoration and colouring	31,643
Colonnade and obelisk	19,789
Architects' expenses	24,810
Dedication ceremonies	44,232
Salaries of officials and clerks	105,139
Publicity and promotion	32,762

Such is the scale, material and financial, of this enormous show. It would be too much to say that all is finished, even now, but there is enough now on the square mile of surface of Jackson-park to occupy weeks in thoroughly seeing, and any visitor who pays his 2s. admission fee can now spend the day in examining an exhibition which beats in bigness anything ever attempted in this line outside of Chicago.

As for the buildings themselves, it is at present impossible to describe them in detail. The Transportation Building has had the finishing touches put upon its florid decorations, and the "golden doorway" of the Grand Mogul, which is the chief entrance, glows resplendent in the eastern sunlight which it faces, the ornamentation being now completed. Installation is complete in the British Transportation Section, but there is still something to do in other transportation sections. Plenty of railway locomotives and trains are in place, including the London and North-Western Company's trains, the old "Rocket" engine, the Great Western broad gauge locomotive, Lord of the Isles; also quite a display of warship and steamship models from Thomson's, the Thames Iron Company, the Fairfield Shipbuilding Company, and Armstrong, Mitchell, and Co. Here, as everywhere else, the British Section is in ample forwardness and in advance of most others. The British machinery exhibit is all ready, and the steam-engines were built and in motion two weeks ago. The installation of the fine arts exhibits was practically complete by May 1, an enormous task, involving nearly 150,000 square feet of wall and six acres of floor space. The Women's Building, which was the first completed, does not appear to have much of anything in it, and is still rather backward. The Fisheries Building has the aquaria all ready, with fish disporting in most of them. The other exhibits are backward in this department, excepting those of Norway and a few others. The United States Building, which exhibits various Government displays, and the outdoor Government displays of lighthouses, life-saving station, hospital, battleship, &c., are substantially ready. A giant tree trunk

from the Pacific Slope stands under the dome of the United States Building, with a stairway ascending through it.

The northern portion of the grounds, as above stated, has the various American State buildings and those built by foreign countries, almost all being typical character, reproducing something of local structure and style. Thus California has an ancient mission building of the early Spanish settlement; Virginia presents the Mount Vernon-mansion, the home of Washington; Pennsylvania reproduces in a manner Independence Hall, with its steeple, clock, and bell; Delaware, Maryland, and West Virginia have spacious and comfortable plantation houses; Utah has a temple, New York a miniature State Capitol, and Idaho a log-house. Germany has an elaborate structure in mediæval high German architecture, France an artistic classical temple, and England has a typical 16th century half-timber country home in Victoria-house. The British executive occupies Victoria-house for offices. Spain and Canada have homes in neighbourly proximity, and Sweden has an elaborate structure, while Brazil and Venezuela have erected grand edifices that are representative of the South American Republics. Japan has built a typical Hooden temple, which is a great curiosity, reproducing the Phœnix Palace, and it is gorgeous in Japanese decoration. The great steamboat landing pier is finished, and is roofed over, with the "travelling sidewalk," which will take people to its outer end, without the fatigue of walking, merely by stepping upon it.

The same correspondent gives the following particulars about the extra accommodation provided for visitors to Chicago:—

Enormous hotels, chiefly of wood, rise on every hand, and the approaches to the entrance gates are lined by shops and shanties. The Fair is actually fringed about on the land side with a brand-new wooden town of vast dimensions, through which the brisk breezes of this windy city blow with exasperating freshness and vigour, causing a shudder when one thinks how desperate might become the fire that may at some time start in this veritable tinder-box. In gazing upon this town of sudden growth, thus environing the Fair, one can realise the extensive preparations Chicago has made to take care of her expected visitors. There are built and building in this new region no fewer than 279 hotels of from 50 to 1,200 rooms apiece. This construction, absorbing a large amount of land, has made a sharp demand for building lots, advancing rentals 50 to 75 per cent. with a most surprising "boom." Along with this all food prices have gone up, so that an idea has been spread abroad that Chicago is animated by a spirit of greed, which can scarcely be admired. These prices, however, will be regulated chiefly by the demand, and the advances, perhaps, may not be maintained. There seems no doubt that abundant accommodation will be found for all the visitors. The new hotels in the "Fair District" have a capacity estimated at 33,500 rooms, and the business section of Chicago are 26 more lar hotels with 14,000 rooms. Here is capacit averaging two persons to a room, for about 100,0 strangers daily, a capacity that is said to be ful equal to the ability of all the railroads to bri visitors into the city. The people who come the Fair will be charged probably all that the traf will bear, but with the vast number of rooms, a the multiplicity of lodging-houses besides, the visito must have some share in fixing rates. If the earli crowds are not too large, an exorbitant scale of rat will soon break down. The fact that Chicag capacity for rooming and feeding people is apparent excess of the railway capacity to bri people in and take them away again would see to indicate an early break in high prices should exorbitant scale be attempted, as there will soon much vacant space at disposal.

THE FOREIGN-BORN POPULATION O THE UNITED STATES.

A bulletin has been issued from the Census-offi at Washington, showing the foreign-born populati of the United States as a whole, from 1850 to 189 distributed according to the principal foreign cou tries of birth. By the Census Law of 1850 a distin tion was made for the first time between persons native birth, and those born in foreign countries. similar inquiry has been made at each census sin 1850, so that since, and including that census, it h been possible to determine the number of persons foreign birth, and the proportion they bear to t total population at each census. These proportio were as follows:—In 1850, 9·68; 1860, 13·16 1870, 14·44; 1880, 13·32; and, in 1890, 14·7 In 1850, the foreign-born population numbere 2,244,602; while in 1890, they numbered 9,249,54 The increase during the decade 1850-1860 w 1,894,095; for the decade from 1860-1870 the was an increase of 1,428,532. In 1880 the foreig born numbered 6,679,943, showing an increase, fro 1870 to 1880, of 1,112,714. During the decade fro 1880 to 1890, the largest per-centages of increase a for persons born in Hungary, or 441·69 per cent.; i Russia, 411·29 per cent.; in Italy, 312·80 p cent.; in Austria, 218·83 per cent.; and in Polan 203·64 per cent. In 1880, persons born in th countries just mentioned did not number 50,000 i any case, while in 1890 they have increased, with th exception of Hungary, to considerably more tha 100,000 in each instance; in the case of Russia an Italy to very nearly 200,000; and in the case o Poland to very nearly 150,000. In 1880, person born in Hungary numbered 11,526, and have in creased to 62,435 in 1890. For the same decad there has also been an increase of over 100 pe cent. for persons born in Denmark and Sweden; fo persons born in Norway and in Portugal ther

; been an increase of more than 75 per it.; for persons born in Canada and New-ndland, 36·78 per cent.; for those born in gland, 36·88 per cent.; for those born in Germany, ·60 per cent.; while, for those born in Ireland, ›re has been an increase of only 0·91 per cent. rsons born in Ireland represented 42·85 per cent. the foreign-born in 1850; 38·93 per cent. in 1860; ·33 per cent. in 1870; 27,76 per cent. in 1880; d 20·23 per cent. in 1890. Persons born in rmany represented 26·01 per cent. of the total eign-born in 1850; 30·83 per cent. in 1860: ·37 per cent. in 1870; 29·44 per cent. in 1880; d 30·11 per cent., in 1890. Ireland and Germany, erefore, represented more than two-thirds of the tire foreign element in 1850 and 1860, very nearly o-thirds in 1870, and more than one-half 1880 and 1890. Persons born in England d Wales represented 13·75 per cent. of the total eign-born in 1850; while, in 1890, they represented ·91; persons born in Canada and Newfoundland nstituted 6·58 per cent. in 1850, and 10·61 in 90; those born in Norway, Sweden, and Den-rk, 0·80 per cent. in 1850, and 10·09 in 1890; ose born in Scotland, 3·14 and 2·62; and persons rn in France constituted 2·41 per cent. of the total eign-born in 1850, and 1·22 in 1890. Persons rn in foreign countries, other than those just entioned, constituted but 4·46 per cent. of the tal foreign-born in 1850; 5·59 per cent. in 1860; 17 per cent. in 1870; 10·13 per cent. in 1880; d 14·21 per cent. in 1890.

HE INDUSTRIAL CONDITION OF EGYPT.

The Belgian Vice-Consul at Cairo, in a recent re-rt to his Government, says that industry in Egypt still in its infancy, and that the amount of capital d labour employed is very limited. The agricul-ral implements used are, as a rule, of the most imitive kind, and if any of the more improved escriptions are to be met with, it is from Europe at they have generally been obtained. The chief dustry, and one of ancient origin, is that connected ith the manufacture of pottery, the Nile clay pplying a superabundance of the raw material. umerous potteries and brickfields are established 1 the banks of the river at Cairo, Alexandria, and the environs of Rosetta. The native filters and one vases are principally made in the Mouderieh of enah, and fine pottery is manufactured at Assiout. he industries engaged in by the Arabs are those of eing, saddle and harness making, shoemaking, rpet making, boiler making, damascening, and ld working. For some years soap has been made large quantities, while a match factory at Alex-ndria, a brewery at Cairo, and some ice factories at iiro, Alexandria, and Port Said, are in existence. he leather and wood working industries occupy veral workshops, a large number are also engaged in the metal industries at Cairo and Alexandria, comprising foundries, forges, tinplate works, and gold working establishments. The share of the Government in the metal industry was originally represented by several establishments intended to provide for the needs of the army and navy, a cannon factory, an arms factory, a cannon moulding factory, a rifle factory, a model workshop, arsenals at Cairo and at Alexandria and shipyards. At the present time, however, all these are closed, and the plant has been disposed of as old iron. The only Government works remaining in Egypt are the railway workshops, for the repairing and mounting of waggons and locomotives, the con-structing and repairing establishments of the *Domaines de l'Etat* and the Daïra Sanieh, and print-ing works at Boulac. The printing industry is represented by a number of establishments in Cairo, twelve in Alexandria, one at Port Said, and one at Mansourah. The paper-mill, owned by Ismail Pasha, and formerly giving employment to 200 workmen, is closed, the plant also in this instance having been sold for old iron. The agricultural industry com-prises two or three factories of alimentary pastes at Alexandria, starch factories, and numerous steam, wind, and horse mills, the finest of which are the French mills of Alexandria, Cairo, and Tanta in Lower Egypt, and of Akmim in Upper Egypt. Those agricultural industries, giving employment to the greatest number of persons, are the flower-essence factories (roses, orange flowers, mint, geranium, &c.), cotton ginning, oil pressing, and sugar making. The textile industries, woollen factories, a few spinning and weaving mills for cotton and flax, the manufacture of blankets, felt hats, waistbands, and silk veils and head-dresses, all give employment to a certain number of workpeople. The Belgian Vice-Consul says that the following industries might be established in Egypt with advant-age and profit:—The manufacture of paper and of furniture, the preparation of preserved provisions, works for cutting ivory, mother o' pearl, and tortoise-shell; rope making, and stone sawing works, and establishments for making rails and hardware.

General Notes.

VIENNA ART EXHIBITION, 1894.—The Science and Art Department has received official information that the Association of Painters and Sculptors of Vienna — *Genossenschaft der bildenden Kunstler Wiens*—purpose holding an International Exhibition of Art in May next year, in celebration of their twenty-fifth anniversary. The Association hope that, seeing the artistic and scientific importance of the Exhibition, England will take part in it. It is hoped that an English committee may be formed, and for details they are referred to the President of the Association. The Exhibition is to be held in the

rooms of the Kunstlerhaus, and will last from the beginning to the end of the month.

MEXICAN CARPET TRADE. — The *Moniteur Officiel du Commerce* reports that a complete revolution has been effected within the last few years in the carpet trade of Mexico. Formerly the chief Mexican merchants only imported European products; it was Belgium, France, England, and Germany which supplied the market. At the present time Germany supplies cheap imitations of the better class articles, and has found a good market. Medium and common qualities of wool are made in the country itself. The United States also supplies carpets in quantities of some considerable importance. The demand is much greater for large carpets than for those of small dimensions; square and rectangular carpets, capable of covering the central portion of large rooms, with striking designs and colours, sell readily in Mexico.

THE CITY COMPANIES' FUND FOR SENDING TEACHERS TO CHICAGO.—Mrs. Fawcett's sub-committee on women's education having received from the Clothworkers', the Fishmongers', the Goldsmiths', and other City companies a sum of rather more than £400 to be used to enable women teachers to attend the educational congresses at Chicago, the money has been distributed in grants of £50 each to the following ladies:—Miss Mitchell, Victoria College, Belfast; Miss Clapperton, St. George's Training College, Edinburgh; Miss E. A. Vinter, examiner to the Fröbel Union, London; Miss M. E. Roberts, the Harpur Trust High School, Bedford; Miss M. V. Thomas, Training Department, Bedford College, London; Miss Louch, Training Department, Ladies' College, Cheltenham; Mrs. Pritchard, the Schools, Kingsland, Herefordshire; and Miss Crees, Head Mistress, Girls' Department, Montem-street Board School, London.

THE NEW KISTNA BRIDGE.—An Indian journal, the *Pioneer*, gives a description of the new bridge across the Kistna at Bezwada. It is designed to carry both the standard and the mètre gauge systems, the object being to enable the Southern Mahratta narrow-gauge railway to have access to the important town of Bezwada, which is the centre of the trade for the great and fertile delta of the Kistna. The importance of bringing the dry Ceded Districts, which the mètre-gauge railway traverses, into direct connection with the abundant food supply, which from the irrigated delta concentrates itself in Bezwada, is great. Such a connection is famine insurance in the true sense of the word. The bridge consists of 12 spans of 300 ft. solid steel girders. Three of the girders had been got up by May, 1892, so that there remained nine to be erected during the current working season. Owing to the lateness of the floods it was not until early in December that a beginning could be made, and in the first week of February all were self-supporting. Such expedition could only have been made possible by the care and forethough with which, during the seven months of inaction every detail had been worked out and designed. Th work has also been done very cheaply, for th engineers expect to show a saving of over a lakh o the estimate for girder erection, and calculate th the rate per ton will work out at a lower figure tha yet touched for spans of the size. The well-work wa exceptionally heavy. The wells used had to be sun to a depth of 80 ft. beneath low water, or 50 ft. belo mean sea-level. From a width of one mile the rive at the bridge site was narrowed to three-quarters of mile by massive training embankments heavily pitche with stone. The bridge was commenced in Decem ber, 1890, and has thus been a trifle over two years i building. There are two more bridges as big c bigger than that over the Kistna which must be mad before the train runs from Calcutta to Madras.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 5...Royal Institution, Albemarle-street, W 5 p.m. General Monthly Meeting.
Engineers, Westminster Town-hall, S.W., 7½ p.m Mr. Robert Carey, "Economical Hydraulic Lifts
Chemical Industry (London Section), Burlingto house, W., 8 p.m. 1. Mr. H. G. Watel, "Th Movement of Air as applied to Chemical Indu tries." 2. Messrs. C. F. Cross and E. J. Beva "New Cellulose Derivatives and their Industri Applications."
British Architects, 9, Conduit-street, W., 8 p.m

TUESDAY, JUNE 6...Royal Institution, Albemarle-street, W 3 p.m. Mr. E. L. S. Horsburgh, "The Waterlo Campaign."
Zoological, 3, Hanover-square, W., 8½ p.m. Messrs. F. E. Beddard and F. G. Parsons, "Not on the Anatomy and Classsification of th Parrots." 2. Mr. Sclater, "Two Horns of a African Rhinoceros." 3. Mr. R. Lydekke "Some Bird-bones from Miocene Deposits in th Department of Isère, France." 4. Mr. A. Smi Woodward, "The Osteology of the Mesozo Ganoid Fish, *Lepidotus*."

THURSDAY, JUNE 8...Royal Institution, Albemarle-stree W., 3 p.m. Dr. R. Bowdler Sharpe, "Th Geographical Distribution of Birds."

FRIDAY, JUNE 9...United Service Institute, Whitehall-yar 3 p.m. Colonel J. B. Richardson, "Coa Artillery Practice."
Royal Institution, Albemarle-street, S.W., 8 p.m Weekly Meeting, 9 p.m. Prof. T. E. Thorp "The Recent Solar Eclipse."
Physical, Science Schools, South Kensington, S.W 5 p.m. 1. Mr. A. P. Trotter, "A New Phot meter." 2. Prof. S. P. Thompson, "Notes c Photometry." 3. Prof. G. M. Minchin, "Th Magnetic Field near a Wire."

SATURDAY, JUNE 10 ... Royal Institution, Albemarle-stree W., 3 p.m. Dr. A. C. Mackenzie, "Falstaff: Lyric Comedy, by Boito and Verdi."

CORRECTION.—In Professor W. M. Flinder Petrie's paper, Fig. 11, p. 681, is inverted in print ing, so that the capital appears below the column.

Journal of the Society of Arts.

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FRIDAY, JUNE 9, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

CONVERSAZIONE.

Alteration of Date.

The Society's *conversazione* will take place at the Imperial Institute, South Kensington (by permission of the Council of the Institute) on *Friday evening, June* 30 (instead of the date previously fixed), from 9 to 12 p.m.

The reception will be held from 9 to 10 p.m in the vestibule, by Sir Richard Webster, Q.C., M.P., Chairman, and the Members of the Council of the Society.

Each member is entitled to a card for himself, which will not be transferable, and a card for a lady. A limited number of tickets will be sold to members of the Society, for the use of their friends, at a charge of five shillings each, if purchased before June 24. After that date, the price of tickets will be raised to seven shillings and sixpence.

Tickets can be obtained on personal application at the Society's House, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, and must be signed by the member to whom it is issued.

Promenade concerts will be given by the band of the Scots Guards in the West Gardens, which will be specially illuminated, and by the band of the Royal Artillery, in the Indian Pavilion, from 9.15 p.m.

A selection of music will be performed in the vestibule, commencing at 9 p.m.

The cards of invitation are now in course of issue to members.

Chicago Exhibition, 1893.

COLLECTION OF GUIDE-BOOKS, &c.

The Royal Commission have formed a collection of Maps, Guide-books, Photographs, Railway and Steamship Guides, Programmes, and other printed matter likely to supply useful information to exhibitors at, and visitors to the Chicago Exhibition.

The collection is placed in the library of the Society of Arts for reference. It is open to members of the Society, exhibitors, or their agents, and others interested.

HANDBOOK OF REGULATIONS.

The final edition of the "Handbook of Regulations and General Information" connected with the Chicago Exhibition has been printed, and can be had gratis on application to the Secretary of the Royal Commission, Society of Arts, John-street, Adelphi. The Handbook contains lists of the Commission, of the various Committees, and of the Colonial Commissioners, Synopsis of the Classification, General Regulations, Regulations of the British Section, Traffic Arrangements and Customs Regulations, Descriptions of the various Buildings and Departments, an Abstract of the McKinley Tariff Rates, description of Chicago and the Exhibition, and particulars of the Railway and other routes to Chicago.

Proceedings of the Society.

INDIAN SECTION.

Thursday, May 18, 1893; The Right Hon. Sir James Fergusson, Bart., G.C.S.I., K.C.M.G., C.I.E., M.P., in the chair.

The Chairman, in introducing Sir Raymond West, said he was not quite at one with him on the subject he was to speak upon; and they were somewhat at a disadvantage in discussing it, as the report of the recent Commission of inquiry into the working of the Dekhan Ryot Relief Act had not yet been officially received, with the resolutions of the Governments of India and Bombay on that report. Nevertheless, there were gentlemen present who had been associated with the working of the Act, and with the inquiries which were made antecedent to its introduction. The Act was passed in consequence of a painful state of things illustrated by certain agrarian riots in 1875, in which the peasantry attacked the money-lenders, which necessitated the interference of the Government. A Commission was issued, and on its report the Act was based. Whilst he was Governor of Bombay, he had occasion to inquire into the working of the Act, and into the condition of the people, and he found the circumstances of the district where the experiment was tried were very peculiar. There was a bare, sterile upland, varied by fertile tracts of cotton soil, and valleys, but exposed to the vicissitudes of periodical drought, and thinly inhabited by a very ignorant but industrious people, the Mahratta Kunbis. Amongst them were settled,

temporarily, the Marwari money-lenders, belonging to a different part of the country, mostly of a different religion, and having no natural sympathies with the people among whom they traded. To these people the cultivators had become largely indebted. It was not necessary to mention the peculiar circumstances and weaknesses out of which that indebtedness frequently sprung, but the fact was that it grew up to such an extent that one-third of the people were hopelessly in debt, and about four-fifths of the decrees obtained against debtors were obtained *ex parte*. The result was that it seemed necessary to legislate in the direction of requiring an examination into the debts, or of going behind the bond, simplification of procedure, an increase of tribunals, and so on. When the working of the Act was reviewed, in 1884, it was found that a great number of ryots had recovered possession of their land, and that, on the whole, the working of the Act had been beneficial. Sir Raymond West was opposed to the principle of the Act, and in the early years of its working disapproved of it; but possibly further experience had led him to modify some of his conclusions. He believed it had been established that the credit of the ryot had not been destroyed, and that he was not precluded from getting accommodation in times of distress. The general result was that those originally favourable to the Act desired an extension of its principles, so that there might always be cheap and accessible courts for the cultivator, under whose auspices solvent debtors might recover possession of their lands, and pay their debts by instalments. He was quite certain that successive Governments had for their object the protection of the small and simple peasantry, of which the larger part of India was composed. This experiment in paternal, if not socialistic legislation, had been tried in a district where alarming distress existed, and he was strongly of opinion that if British rule in India was to be strong and lasting, it must take account of the sufferings of the poor, and present itself as both merciful and sympathetic. They might not have attained an ideal system, but at least they had laboured earnestly to fulfil the high duties they had undertaken in that great country.

The paper read was—

AGRARIAN LEGISLATION FOR THE DEKHAN, AND ITS RESULTS.

By Sir Raymond West, K.C.I.E.

It is a commonplace of economical history that the ownership of land suddenly placed in the hands of a peasantry will, in a large number of cases, be lost, or made almost useless, through improvidence. This has been the experience of many countries in Europe. Of the mass of proprietors untrained in the responsibilities of such a position, a considerable proportion quickly become involved in debt, and are on the whole far less happy than they were in their previous position of dependence. Gradually, men of this class are elbowed out by a more thrifty and energetic class; by a process of natural gravitation the land finds its way into the hands best fitted to use it under the new conditions, and economic equilibrium is restored. The course of events in India has been very similar, but the changes have been even ruder and more rapid, as a Government, more advanced than the people, has, in some instances, stimulated the natural process of evolution, almost to the point of convulsion, and launched the masses of the rural population upon a career of unrestricted freedom, activity, and competition, for which by nature and tradition they were unprepared. It may seem strange to us in England, but there are millions of human beings who are unfit for complete civil independence and unqualified ownership of property. They are unfit in this sense, that, their qualities being what they are, a higher social life is to them a burden or a snare. They can enjoy property and its fruits, but they cannot manage and economise. In the struggle of competitive life which succeeds to custom, fixed relations of classes, and clear-cut grooves of employment, they break down, and either perish, or else transmit a helpless, unpractical character to descendants, who then for ages constitute the dregs of society. This is the description of an appreciable minority of the peasantry of India. Their natures were fairly well suited to the old conditions of existence; they are wholly unsuited to the new. Having been invested with property, they are impelled to encumber it or part with it. Having acquired a capacity to engage in transactions, they plunge into debt. Free-will, embodied in contracts, should be accompanied by sound intelligence, foresight, and sense of pecuniary obligation. For those who are not thus endowed, freedom may be no more than that conferred on a man thrown overboard in mid-ocean. This has been so with the Indian gentleman as with the peasant. Everywhere debt and distress have resulted from enlarged powers of disposal. The birth of a new organisation has been attended with suffering and tears. Less haste and thoughtless zeal might have been desirable in the governing class, but, for good and ill, the change has now been almost accomplished. We English, in fact, immersed as we are in individualism, have not a theory or a mode of administration adapted to any but an economically progressive society. India gains much

from our presence, but the new track along which we force it must sometimes wound its unaccustomed feet. We can but be consistent, considerate, and resolved, as far as we can, to train the people committed to our charge to the virtues by which they may sustain the burden of a higher calling. We must cultivate a sense of duty as to the fulfilment of obligations; we must check fraud and over-reaching; we must not encourage poverty to look for injustice as a remedy or solace. The penalties for a weak people's failings must not be too severe, but they must not be converted into rewards. We must avoid the extreme oscillations of policy, which propagate a levity of character akin to that from which they spring. Munro pressed this in his day; but it is not yet too late to insist on a principle which is still too often forgotten or set aside.

A German publicist once wrote:—"Let us hope that, in our next contest with France, we may have to pay the indemnity." The paradox concealed a pregnant truth; a sudden influx of money, such as occurred in Bombay in consequence of the Civil War of the United States, and the consequent dearth of cotton, is but a mixed and qualified benefit. Habits are engendered, and engagements entered into in anticipation of a continued affluence, which prove an intolerable burden when the flood-tide subsides. Thus the people of Germany have profited but little by the French indemnity. The great prosperity of Ireland, a generation ago, led to borrowing from the banks which afterwards became a serious embarrassment, and made the farmers ready to accept the teaching of the Land League. Australia affords a new and striking example.

Similarly, the ryots of Bombay, counting rashly on the permanence of the good times of 1863-66, incurred debts which were far beyond their means when prices sank again to their normal level; and when, after two or three years of severe scarcity, they had, in 1877, to face actual famine, it is hardly surprising that there was a general break down. The pressure had been severely felt for some years before. The ryots, untrained to habits of forethought and self-control, had prodigally wasted or encumbered the ownership of their lands recently bestowed on them by the Revenue Survey of Bombay. In many instances they had been forced by misfortune or personal imbecility into debts which they could not discharge, and such debts have hastily been taken by some sympathisers as a type of the whole. The capitalist class, on the other hand, were led into an excess of credit by the new securities placed within their reach, and by remedies against the property and persons of debtors, far more effective and exhausting than had been allowed at a corresponding stage of social development in Europe. The money lent to small proprietors was, in many cases, lost: the creditors sought to recoup themselves by a rigorous enforcement of their claims wherever recovery was possible. There were many sales of land; there were still more cases of land-holders who, as judgment-debtors, retained possession of their small holdings only by favour of their creditors and on condition of handing over to them all the profits of their toil. The sphere of rights and duties had been prematurely enlarged beyond the moral capacity of the people. The intended blessing became to many a curse, and wide-spread distress quickly falsified the jubilant predictions of those who had relied too much on the "magic of property" as a well-spring of all economic virtues. Human nature refused to march along with system and theory. It even turned restive under the blessings imposed on it. There was general discontent amongst the agriculturists; there were disturbances, violence to sowkars, and destruction of their property.

A Commission was appointed in 1875 to inquire into the causes of the Dekhan riots. It found the state of things to be pretty much as I have briefly described it. The fair rents conceded by the British Government, the fixity of tenure, the freedom of transfer—all had resulted only in a more deep-rooted and hopeless distress, through the inability of the people to use without abusing their new privileges, through the inability of the Legislature to grasp comprehensively the peculiar conditions with which it had to deal, through the inability of the judges, fettered by unyielding rules, to administer the generous equity for which the situation imperatively called. The judges of first instance, a generation ago, required a strict control and iron rules. The traditional corruption and indifference were thus expelled from the Courts; a traditional narrowness and harshness succeeded. A prevailing ignorance and pettiness of jural outlook had long pervaded the superintending authorities. A general elevation and expansion of judicial capacity were needed, a nearer approach to distributive justice in determining legal relations and remedies. The outcome of the Commission's

report was the Dekhan Agriculturalists' Relief Act. It was a brave attempt to set the relations of debtor and creditor right, by substituting for a harsh but radically just system, a method that was lax and uncertain, and unjust in this, that it superseded the contracts of free men by the mere discretion of judges. The intervention of equity when "right too rigid hardens into wrong" is a wholly different thing from a universal upsetting of transactions with or without sufficient reason. When, as under the Act, all executory engagements are uncertain and unenforceable, while sales of property are unchecked, it is inevitable that sales shall multiply, and the proletarian class increase. Credit, enterprise, and mercantile development are hampered and retarded under the Act by the hazard that attends common and necessary dealings. To make the recovery of debts impossible or very difficult gives the debtors a present gain at the cost of future privation, and when sales, at the same time, remain free to agriculturists, they are pushed on, as by an evil fate, along the path that leads to landlessness and pauperism.

The statement of objects and reasons with which the Dekhan Agriculturists' Relief Act was introduced sets forth that the ryots' difficulties are due in a great measure to the unsatisfactory relations subsisting between them and the money-lenders. The remedies proposed were :—

1. Safeguards against creditors' frauds on their debtors.

2. A system of conciliation, supplementing additional Courts, and a simpler and cheaper disposal of suits.

3. Investigation by the Court, on its own motion, of the entire history of the transactions between litigating parties—in other words, "going behind the bond"—without, or even against, the wish of the defendant.

4. Restriction of the sale in execution of a ryot's land, and a new scheme of relief to insolvent debtors.

The main purpose aimed at by the provisions of the Act, and the mischief sought to be remedied, were indicated thus :—"To prevent the gradual transfer of proprietary interests in the land from the martial and cultivating classes to the trading and money-lending castes of Indian society." Its other objects were subsidiary to this; and by its results in this respect its success or failure as a work of legislation must be judged. But if success has in any material degree been gained, the further question presents itself of the collateral efforts, which, in the case of this as of other laws, may be not less important than its direct and foreseen consequences.

The Act provides a system of registration for all instruments, however insignificant, executed by an agriculturist, so that a promissory note, even for five rupees, or a receipt extinguishing a like debt, would be useless, unless duly registered with elaborate ceremonies. To this it was objected that the loss of time and money caused to poor borrowers would be an intolerable addition to their burdens. Documentary evidences of debt would thus be driven out of use, to the increase of uncertainty and fraud. Pledges and sales on credit at enhanced prices would take the place of loans. Petty traders, and other non-agriculturists, would obtain credit, on terms which would relatively operate as a premium on their occupations, and a fine on the agriculture which it was sought to encourage.

The system of "conciliation" embodied in the Act was an imitation of that established in France for the settlement of petty and simple cases. But it—contrary to the French system—embraced all classes of cases; many, therefore, to which such a system was quite inapplicable, as, for instance, mortgage cases in which the rights of joint families have to be adjusted. Admitting the purely dependent condition of the agriculturist, this system, it was objected, involved some danger. "It affords," it was said, "a means—unless the work under it is most carefully done—of defeating the whole purpose of the Bill. Registration, stamp-duty, troublesome investigations, 'going behind the bond'—all may be avoided by simply taking the borrower before the conciliator. To him the debt will be admitted. An adjudication will be drawn up accordingly, and this will become a decree from which no appeal can be made." Thus a mode of settlement, useful and beneficial within its proper limits, might be perverted and discredited.

It is a generally-received principle of jurisprudence, as of the Hindu law, that when the parties to a transaction have committed their intentions and their agreements to writing, the written contract is to be taken as conclusive. It is framed for the purpose of preventing disputes, not as a basis for contention. Still, it may be set aside for fraud, a qualification which was embodied in the Bombay Regulation of 1827, providing that a written acknowledgment of debt should not be conclusive as against counter-evidence.

By the Dekhan Agriculturists' Relief Act, a new system was introduced. The enactment of the regulation is repealed. The Court, by examining the parties, must find out, if it can, some ground of defence against the plaintiff's claim; and it must reconstruct the account between them on a prescribed plan, without regard to their mutual agreements.

As to the enforcement of decrees, the Act provides that an agriculturist shall not be arrested or imprisoned in execution of a decree for money. His immovable property can be sold only if specifically mortgaged. An agriculturist debtor to an amount of less than fifty rupees may be wholly discharged from debt, on paying what the Court thinks him able to pay. In other cases specially-indulgent rules of insolvency and relief are provided.

Against this system, as a means of preventing dispossession of the agriculturists, it was objected that the creditor would be driven by it to secure every advance to a ryot by a mortgage of his land. "Mortgages," it was urged, "are a stepping-stone to landlessness, and the change which the Government desires to avert will be hastened by the means devised to prevent it." "But, even a mortgage," it was pointed out, "will have its perils for the creditor." And, "for every risk the borrower must pay. . . . Much land might go out of cultivation which, by obtaining money on easier terms, the ryot could retain. The ordinary effect, however, would be to substitute sale for mortgage. . . . . . The Bill forces the capitalist to exact landed security and then surrounds his position as mortgagee with so many perils and entanglements that it drives him on to become a purchaser." "Bad security," it was observed by another critic, "means high interest, and the money-lender's security is now more than ever weak, seeing that he cannot touch his debtor's person, nor his house, nor his clothing, nor his cattle, nor, unless the debt be specially secured, his land." It was suggested that sowkars who refrained from buying the ryots' crops in advance, or selling goods at enhanced prices, instead of lending money would, by the Bill, be made unforbearing and inexorable in exacting repayment.

The objections urged against the Bill were not allowed to prevail; nor was the suggestion accepted of capitalising part of the cost of working the proposed scheme, and thus raising a loan-fund for rescuing ryots from the clutches of extortionate money-lenders. The Act was passed, and we are now in a position, after thirteen years, to form a fair judgment on its operation and consequences.

The Act, after it had passed, in 1879, was at once brought into operation. A special superintending judge, with two assistants, was appointed to revise the proceedings of the judges of first instance. The staff of these judges was increased to a number which has since been found needlessly large. Court fees, which are so heavy a tax on ordinary litigation in India, were, for the benefit of agriculturists, cut down by one-half. In the case of mortgage redemption suits, they were for some time remitted altogether; but as this led to the institution of a large number of speculative suits, the indulgence was cancelled for the district of Satara, where the abuse was most flagrant, and agriculturists were there compelled, instead of suing gratis, to pay one-half of the ordinary fees and charges. In twelve talukas, again, the subordinate judges were empowered to return one-half of the institution fees actually paid in all cases wherein a consent decree should be passed at the first hearing of the suit. By the Act itself, and by the rules framed within it, the collectors in the Dekhan, as administrative heads of the several districts, were invested with powers in the execution of decrees such as made them guardians of the ryots' lands to the utmost extent compatible with any freedom of disposal by the ryots themselves. The support of an agriculturist and his family is a first charge on his land, as against creditors by decree or insolvency. The agriculturist can obtain a complete discharge while retaining the estate reserved for the support of himself and his dependants.

The office of Special (superintending) Judge under the Act has, ever since it came into force, been filled by gentlemen of distinguished ability. The new law, therefore, has been launched and maintained with quite exceptional advantages over the ordinary law. Money has been freely spent, revenue has been sacrificed, the best ability has been enlisted in the service of the experiment. The present Special Judge is a zealous supporter of the system he administers. From the annual reports made by him and his predecessors, from the reports made, in 1883 and 1890, by officers specially appointed by the Bombay Government, and from the report made by the Commission appointed by the Government of India, in 1891, we may gather further and clearer information on the working of this Act, perhaps, than on that of any other measure

touching judicial procedure and the law of debtor and creditor.

Chapter II. is the most important part of the Act. It prescribes a special procedure for the investigation of suits, and special indulgences in the method of execution, which were intended to surround the agriculturist with peculiar safeguards. It "purports to invest subordinate judges with what are termed Small Causes Court powers, but enlarged, so as to include mortgage cases." But the recent Commission observes: "there is no real Small Causes Court procedure under the chapter." Instead of the summary method appropriate to a Small Causes Court, Sections 12-13 prescribe an elaborate method of investigation and of account-taking." Then, "finality of decision is banished altogether," as "Chapter VII. practically gives every party in every suit an appeal, though under another name." The power of revision without application is virtually not exercised.

In cases of a certain value, the parties may submit to the procedure of the Act or reject it. Now, under the Act the fees otherwise payable are reduced by one-half. Yet, in spite of this strong inducement, the ordinary procedure is chosen in preference in one half of the cases. The Judge being on either choice the same, the preference of the more expensive ordinary procedure affords strong proof of the distrust or dislike with which the cheaper course is regarded by the persons concerned.

Section 3, the Commission observe, brings within the operation of the Act, as to a large number of suits, all classes, not merely the agriculturists for whose protection the measure was devised. This is indisputable. Yet, if reduction of interest, revision of contracts, and examination of the parties are desirable to guard the agriculturist, they are not less desirable to guard the labourer or artificer, who may equally be imposed on and may suffer as much. There should be an equal desire and care to prevent the spoliation of one class as of another, and agriculturists, as such, are not necessarily weaker and more ignorant than others of the feebler sort. The proper ground for a special interposition and special scrutiny is whatever suggests an unfair advantage taken of weakness by strength or astuteness; and ignorance, helplessness, and misplaced confidence may as well be found in other classes as amongst agriculturists. Many of the latter, indeed, as the working of the Act has demonstrated, are as unconscientious and almost as cunning as the professional money-lenders.

Section 7 requires a summons to be issued for the final disposal of a suit wherever it appears possible to dispose of it at the first hearing. But, in fact, the case very seldom is so disposed of—hardly ever, indeed, except where there is really no contest. "It follows," the Commission say, "that, in many cases, one party or the other is put to much unnecessary inconvenience and expense in producing his evidence at the first hearing. In the interests of the public, therefore, the clause should be repealed."

A second clause of the same section requires the subordinate judge, in all ordinary cases, to examine the defendant as a witness. This the Commission approve, and it may certainly be deemed necessary, in order to give full effect to the principle of "going behind the bond." The defendant, when conscious that he has no defence, usually fails to appear. A warrant is issued, he is brought to the Court, and, if any semblance of a case can be extracted from him, a day is fixed for taking the evidence. But again he fails to appear. If when brought up he avers, in order to gain some further time, that the consideration for the debt was a previous debt, the plaintiff is examined, and then the hearing is adjourned that he may produce his old accounts. The delay and harassment and expense are an intolerable burden in those cases in which there is, after all, no real answer to the claim. This is so in six cases out of seven. In the seventh case the ryot generally could, and would, contest the claim just like any other man. It appears, from the elaborate report of Mr. Woodburn, that in about six cases out of seven contested by defendants, in the Dekhan Courts, as elsewhere, the judgment is for the plaintiff. Considering the accidents which may cause a failure of proof, this proportion shows that wholly unrighteous suits are very rare. Outside the Dekhan the claims wholly dismissed amount to only 3 per cent., which points most strongly to the same conclusion. As but very few unfounded suits are brought, it is not surprising that about 40 per cent. of them are uncontested. The *ex parte* decrees against agriculturists fall to about 6 per cent. of the suits in the Dekhan; but then when the defendant has been virtually forced on a contest the result is a per-centage of decisions absolutely against him, more than twice as great as elsewhere. In these 20 or 25 per cent. of the suits there ought to have been

no contest at all—the expense and loss of time have been caused by the special provisions of the Act. There yet remain, no doubt, a larger percentage than elsewhere of judgments wholly for the defendant—a small per-centage still of 7 or 8—but this is due to the peculiar provisions of Sections 12 and 13 of the Act. The statistics fairly considered bear out the opinion of all the subordinate judges, that "almost the only reason for *ex parte* decrees is that the defendants have no substantial defence."

It is not, of course, to be said that this forced presence and examination of the defendant never serves any useful purpose. It may do so in one case out of twenty, in which he would otherwise suppress a just defence, but the small advantage costs too much, and any prejudice sustained under the ordinary law by the defendant through his non-appearance is due to his own fault. It is not fair that thirty or forty debtors and creditors, and still more witnesses, should be harassed and put to expense, merely that a defence may be extracted from one stolid or perverse debtor, which he was unwilling to put forward for himself. As to the moral effect of the temptation put in the debtor's way by this system, one subordinate judge says:—"There is more tendency now than before on the part of agriculturists to tell false stories about repayments and nature of debts." Another remarks:—"Hard swearing has, therefore, become the order of the day, and the demoralising effects thereof must be incalculable." These are considerations of at least some weight to set in the scale against the theoretical advantage of examining the defendant in every case, so as, if possible, to make out a ground of dispute for him.

It has sometimes been said that the enforced attendance of the defendant not only in most cases does him no good, but it may even be turned into a means of harassing and oppressing him. He may be dragged to the Court just when he is most wanted in his fields. The Commission think this objection unfounded, and certainly creditors in general have not any tendency to gratuitous oppression. Yet even a sowkar may lose his temper and his patience, and then, as a subordinate judge says:—"There is nothing to prevent the sowkars, if they be minded to be spiteful, so to time their suits as to compel the agriculturists, defendants and witnesses, to be absent from their fields when they can least afford to do so." As to the ryots themselves, he says:—"Their personal attendance in Court being compulsory, they are sometimes seized in the midst of their agricultural operations and marched off to the Court. I do not think the agriculturists quite appreciate this kindness of the Sircar, and if they only knew how to give voice to their thoughts, they would be the first to complain of a provision which snatches them away from their fields, regardless of the season of the year." The Commission appear to have ignored this evidence. They say:—"The case is first entered in a *sine die* list, and it is impossible for the plaintiff to foretell how long it will remain there." This, if quite correct, would be a heavy charge against the procedure, but as the older suits are disposed of, newer ones are in succession brought forward, and the plaintiff, who files his conciliator's certificate and pays his process fee at a well-chosen time, can be practically certain within a fortnight of the time when his debtor will have to appear, or to abscond until the bailiff has gone back to the Court. When this happens, a warrant is issued on the plaintiff's paying the fee, and after some days wasted in hiding, the conscious debtor is at last landed in the Court. There he is examined, and perhaps, in order to gain time, he says he has paid something to his creditor on account, without getting a receipt. An adjournment is granted, and the whole process may have to be repeated. Heavy costs are incurred. "It is mentioned with pride," says a subordinate judge, "that, under the Relief Act, *ex parte* decrees have been reduced to a minimum; but nothing is said about the cost at which the reduction is purchased." Under the ordinary procedure of the Indian Code, the Court may require the presence of a defendant wherever it appears necessary. He may be questioned by the Court; his examination is recorded. If there is a substantial defence, it can be and is elicited. This is all that justice requires, and all, therefore, that justice approves. The discretion given to the judge should be used fully, but without any unfair suggestion, and without the huge loss of time and money through enforced defences and the worrying of witnesses, who five times out of six can give no help except by "hard swearing."

The Commission are of opinion that "the expense of enforcing the attendance of the defendant should not, as at present, be thrown on the plaintiff." This would suit the plaintiffs admirably; but the defendants arrested, in five times as many cases as now, in order to make them, if they can, dispute the claim, will certainly be the first to complain of a provision which is so kind to them against their will.

Section 8 of the Act excludes written statements in the most numerous classes of cases. Section 10 shuts out an appeal except in the imperfect form of revision. The revising judge, unaided by written statements, cannot know for certain what case was made by either party. The Commission say that "there is no object in retaining this section." There can be none unless it is desired to shut out the light.

Section 9 provides for a summary procedure in petty cases, which is discretional and hardly ever used. The Commission say it should be repealed, and it would be no loss.

Sections 12 and 13 are the core of the Act as to procedure. Under the former, the Court generally, even in "cases in which the amount of the claim is admitted, shall be bound to inquire" whether "the admission is true, and is made by the debtor with a full knowledge of his legal rights as against the creditor." When a defendant who has admitted the claim made against him is subjected to examination conducted on such lines, it is hardly possible that he should refrain from urging something in his own excuse. It appears that about two-thirds of the suits against the agriculturists, to which the section applies, are contested, and in about one-half of these, the past "history and merits of the case, from the commencement of the transaction between the parties," have been inquired into under this section and Section 13. Instead, therefore, of starting in these inquiries from the sure basis of the admitted contract, the Court goes back into the past to find out the relations which the written contract was meant to supersede, and which, according to received jural principles, it ought to have superseded. The judge is exempted from this process only when he can record special reasons for supposing that the contract and the admission are irrefragable. In a majority of cases he finds that they are, and thus justice is satisfied. But, in a certain number, he cannot suppose that nothing to the defendant's advantage can be brought out by applying the provisions of Section 13, and in those cases he must apply the section. This sets aside the contract made by the parties. It directs separate accounts to be made of principal and interest. Interest, according to Section 14, is to be computed, not at the rate agreed on, but at such rate as the Court deems reasonable. The profits of land agreed to be set off against interest must be computed according to the discretion of the Court, and debited to the mortgagee. If in any case the interest exceeds the principal, the excess is to be disallowed; nor are agreements having the effect of rests to be recognised.

It is manifest that all freedom of contract is annulled by these provisions. A capitalist cannot lend, or sell goods on credit, nor can a borrower or purchaser bind himself to pay his creditor except on such terms as a subordinate judge—years afterwards perhaps—may deem reasonable. The subordinate judges are capable and honest men, but they are entirely without mercantile experience, nor are they allowed to remain so long at one Court as to become thoroughly acquainted with the economical conditions of the neighbourhood. In all credit transactions, risk is a great, if not the chief, factor in the rate of interest; and how can a judge, especially a generation afterwards, tell how this was estimated by the parties concerned? If the rate of interest is to be arbitrarily readjusted, why not also the prices of goods sold? Why not rents, and salaries, and rates of insurance? Such readjustments of accounts, on abstract notions of what may have been reasonable, are really as much guesswork as the computation of the profits that may have been made of land twenty or thirty years ago. Practically the attempt was in most cases abandoned in favour of a purely arbitrary "splitting of the difference." In the earlier years of the Act, thousands of cases were disposed of in this fashion, to the ruin, in many instances, of the capitalist class. Now, in lending money, the sowkars have learned so well how to protect themselves that, on an average of the last three years, the Commission report there were only 14 cases per annum "inquired into" in each Court. But, in thus guarding themselves against the pressure of a one-sided law, the sowkars have had to mould their transactions in certain set forms, and to refuse credit in innumerable cases in which it could otherwise have been granted. The free play of intelligence and enterprise has been checked, along with that infinite pliancy of agreement and obligation by which capital is made productive and industry is nurtured. Devices have been resorted to by which the operation of the Act is wholly escaped.

The Commission are in favour of the obligatory inquiry into every case, even when the claim is admitted. "But the inquiry," they add, "should be confined to the facts so far as they may be ascertainable, and should not be supplemented by assumptions where evi-

dence of facts fails: and when a claim is admitted, and has been made with a full knowledge of the relief which the Court is entitled to grant, it should be incumbent on the Court to accept the admission. Compromises should be guarded in the same way as admissions." These suggestions imply a severe criticism on the past working of the Act: but they do not meet the difficulty pointed out by some of the subordinate judges, that by limiting itself to what is ascertainable a Court puts a premium on the destruction or concealment of old accounts and other documents. If, too, a Court is to accept an admission only when a debtor has "a full knowledge of the relief" he may claim, the admission must go for nothing in nine cases out of ten. No two judges, in fact, take exactly the same view of the relief to be given in any case that is the least complicated. "Substantial justice," as contrasted with the fulfilment of contracts, has, as a subordinate judge observes, "no fixity: it varies according to individual sympathies and caprices. . . . . . One Judge may award interest at one rate, another may award a higher or lower rate." How, then, shall an ignorant ryot have "a full knowledge of the relief" he may obtain?

It was inevitable that under an Act framed like the Dekhan Agriculturists' Relief Act, the amount of the decrees obtained against agriculturist debtors should fall far short of the claims set up by the creditors. Unless, indeed, the burden pressing on the ryots could be greatly reduced, the Act would be a failure. Although the proofs of fraud on the part of creditors were but few, and generally inconclusive, yet a general feeling prevailed that the ryots had not only been outwitted, but grossly and pitilessly cheated, and that this cheating was the cause of the abject poverty in which too commonly they were plunged. But for judges, who were to administer justice, it was a misleading and mischievous principle that debts should be reduced as far as possible. The provisions of the Act, especially Sections 12 and 13, strongly invited the judges of first instance to make out a case *quand même* for every agriculturist litigant. The law, down to the year 1879, had regarded written contracts as conclusive, except where they could be reasonably impeached. Creditors had not cared to preserve the evidences of obsolete transactions wholly superseded by more recent settlements and by new engagements. Mortgagees on terms of an antichresis, or *vivum vadium*, had been under no obligation to keep accounts. The absence of any such obligation had been what specially recommended this form of mortgage to debtors and creditors alike, and it had been expressly suggested by the statute-law. When, therefore, a creditor, suing on a promise to pay the balance of an hereditary debt, many times partially discharged and many times renewed, was suddenly called on as a suitor to prove every step in the series of transactions which, to him, perhaps, as to his debtor, were but a tradition, he could not but fail. The mortgagee, who had annually taken the profits of the mortgaged land, whether great or small, in lieu of interest, could not tell, any more than his debtor, what result might be brought out by a conjectural estimate for each bygone year, and an account made up on a new and wholly artificial principle. The defendant was to be instructed in every possible objection that could be raised against the plaintiff's claim. Being human, he could not but yield to such a temptation, and sometimes deny or question claims which he knew to be perfectly just. Over all presided the spirit exulting year by year, not in the detection and defeat of fraud and extortion, but simply in the small proportion recoveries by creditors bore to their claims. This was proclaimed as the special success and glory of the process of "going behind the bond," of coaching the ryot in pettifogging, and of imposing impossible conditions on men who sought their rights.

"In hundreds, perhaps thousands of suits," says a subordinate judge, "it was for several years customary to hold that half the amount of the bond was principal," and "the view that payment of eight annas in the rupee is substantial justice was for several years much in favour with the special administrators of the Relief Act." One may be surprised, then, that the reductions were not much greater. Some just and many unjust gains were made by the class of mortgagors. In some few cases the mode prescribed for settling the accounts operated to their disadvantage. But seeing how far a real equity would have lightened the ryots' burdens, was it worth while to upset all their notions of legal obligation for so meagre a result? In how many of the 10,000 decrees for redemption on payment in full, or in part, such payment has actually been made does not appear; but out of a large number of instalment decrees a very small proportion have been regularly or even irregularly satisfied.

In more recent years, stress has been laid on the fact that the average reductions under

the Act do not differ materially from those made by courts administering the ordinary law. The reason of this is, that the old claims have been exhausted, or abandoned, or compromised, and that, in making new advances, the money-lenders have found a means of turning the provisions of the Act entirely to their own advantage. Only about fourteen cases per court for "going behind the bond" arose each year from 1889 to 1891 inclusive. The weaker members of the money-lending class have been squeezed out, banished, or urned into traders; the stronger lend more stingily, and exact more rigorously, with economic effects which will be discussed presently. It is enough now to say that they correspond to the teachings of economical science.

It was quite in consonance with the spirit presiding over the working of the Act that in a considerable number of cases, not only was the interest on loans and debts refused, but the creditor was mulcted of more or less of the principal. Where accounts had been settled, and new engagements entered into, these were generally set aside as a basis for regulating the amount of interest claimable, which was limited as a maximum to the amount of the principal. By another logical step, the courts, when unable, as they often were, to trace the origin of a long series of transactions, inferred that, as the earliest engagement traceable might be composed as to a moiety of interest, it was so composed. The principal was then found by halving the debt as first acknowledged or ascertained. There was no halving of the subsequent payments and interest on them, and thus the account sometimes turned the creditor into a debtor. This method of defrauding creditors was, after some years, stopped by the High Court, but, in the meantime, limitation was running, and "the Commission [of 1892] came across numerous suits on old bonds, in which the creditors" felt forced to abandon all claims for interest. They could not thus escape having their claims cut down by one-half, but if they gave no information they were not punished further.

The absolute disregard for the contracts made by the parties reached its climax in the case of suits for the redemption of mortgages. The most common form of mortgage in the Dekhan was that of an antichresis, in which the profits of the land mortgaged were set off against interest on the money lent. In order to facilitate the recovery of their lands by ryot-mortgagees, the ordinary court fees were in their case wholly remitted, while their creditors, the money-lenders, had to bear full costs. Litigation having been made so cheap, it was natural that hundreds of speculative suits for redemption should be brought. Mortgages were allowed to be proved by mere reported admissions, and the defendant in possession was called on to prove the terms of a mortgage, the existence of which he wholly denied. Failing to produce the alleged mortgage, he was turned out in favour of the claimant.

A common mode of paying off a debt was by granting a lease for a definite time in discharge of principal and interest. Under the Act lessors came in claiming a return of their land thus leased, and in many cases succeeded, though the lessees could not have recovered their money. Section 15 A of the Act was supposed to warrant this annulling of leases as well as the cancelling and reconstruction of mortgages, until, after some years, it was established that an enactment applicable only to mortgages could not properly be applied to cases where no debt remained as the basis of a mortgage.

Another anomalous result of the Act was, that when persons not agriculturists had, or supposed they had, such an interest in land once mortgaged, as an agriculturist could enforce, though they could not, it was only necessary to transfer some minute share of the extinquished interest to an agriculturist to enable him, and, through him, themselves, to regain the whole of the long-lost property. Seeing on what slender foundations a claim to redeem could be based, it is plain that proprietary rights throughout the Dekhan were thus most seriously shaken, and a premium was held out to fraudulent and unfounded claims, which could not but prove mischievous.

The number of speculative suits was, in fact, so great that, at the end of 1885, gratis litigation in Satara had to be abolished, on the recommendation of Dr. Pollen, the Special Judge. Half-fees were exacted on redemption suits as on other suits in that district, and the number of suits at once sank to a normal level.

Still, however, the special provisions for upsetting the terms agreed on in a mortgage are in force, and they are applied quite apart from any purpose of giving effect to the true, original intention of the parties. Wherever the Act is thus employed, the result is a matter of mere chance. Dr. Pollen, when Special Judge under the Act, properly and

candidly pointed out that, "Ascertaining the profits of mortgaged lands is, for anything but a short period, purely a guess." The recent Commission say:—"The Courts were thus, in nearly every case, reduced to framing conjectural estimates of the average annual profits." "In some cases the profits were calculated on the basis of the assessment. In other cases the court simply struck a mean between the hopelessly divergent estimates of the parties or their witnesses. But, perhaps, the commonest method adopted was to direct a local inquiry, and to be guided by the result."

A local inquiry, it may be observed, would bring in no real information about the profits of long-past years, of which no record had been preserved. The conclusions arrived at by different judges in the same cases were widely different. Dr. Pollen is quoted by the Commission as saying that an error, "of only a rupee or two, in an estimate of average profits, might make a difference of nearly Rs. 1,000 in an account running for thirty years." In some instances the ryot-mortgagor might thus be put on impossible terms of redemption; in others the mortgagee might be cheated of his investment. In almost every case the law, superseding the contract of the parties, would do wrong to the one or the other.

If, instead of the mortgagor coming forward to redeem, the mortgagee comes into court for sale or foreclosure, where an agriculturist has become interested to the smallest extent in the property mortgaged, the settlement is equally taken into the hands of the court. The contract is set aside, and the parties are subjected to such terms, often most ruinous to the creditor, as I have already described. No mortgagee under an old mortgage can enforce his rights without serious peril, none can tell when redemption may be demanded, or on what terms it may be granted. No allowance can be looked for on account of permanent improvements, and thus intensive cultivation is wholly checked.

The Commission think that "the policy of setting aside, with retrospective effect, agreements to take the profits of mortgaged property, without an account, in lieu of interest, deserves serious reconsideration." Such agreements have been, to some extent, superseded under the pressure of the Act, but their convenience has preserved them from extinction. The injustice of the retrospective rule becomes manifest, on a comparison of Section 15 of Bombay Regulation 5 of 1827; for, by that, land mortgaged with possession, is, *prima facie*, made the sole security for the mortgage debt, and its profits are to be an equivalent for interest. To the same effect but stronger in Act 28 of 1855. This was the rule under which thousands of transactions had been entered into which were simply annulled by the Act. It was one based on a knowledge of the real needs of the native community, and it only required guarding against abuse. When land is taken as security, the interest on the loan should not be allowed to exceed the produce. If it is, then interest may accumulate, even while the mortgagee has the sole enjoyment of the land, and all hope of redemption soon vanishes. If it is desired to make land a part security, the contract should be divided, so as to keep the mortgage portion wholly apart.

It happened sometimes, on taking the account between a mortgagor and a mortgagee in possession, that the profits of the land were found not to be equal to a reasonable interest. The deficiency was added to the principal. This was forbidden by the Special Judge, and now the account is simply set aside, if the creditor would profit by it. The case is not so bad as that which was once common, of the mortgagee's having to give up the land and pay money besides; but the principle is the same in both cases. It was not surprising that, until they had found out the means of evading the Act, the sowkars should have loudly complained of it as iniquitous. "So convinced are they," Mr. Woodward reported, in 1883, "that justice is not to be obtained by them under the Act, that my information makes me believe in their willingness to compromise debts at one half, or less, their actual ascertained amount, paid down in cash."

The duty imposed on the courts of resettling the terms of mortgages, and opening up those which had long passed into sales or become irredeemable, has been abused not only by agriculturists, but by sham agriculturists and by parties giving agriculturists a small or nominal interest merely to create a right of redemption on discretional terms, where none whatever would otherwise subsist. The Judge of Ahmednagar reports:—"In several instances the courts have allowed a speculative purchaser at a court sale, for a nominal sum, to redeem lands long in the possession of the mortgagee for much less than the sum which would have had to be paid under the general law. I myself have had

cases in which one money-lender has succeeded in getting himself declared an agriculturist, and recovering land which he had bought at a court sale from a rival money-lender, a mortgagee in possession, without paying the full amount which would have been found due if the original contract had been enforced. It is probable that, in a large number of redemption suits, the original contract has been set aside under the Dekhan Act in favour, wholly or partially, of a stranger."

In their detailed examination of the several provisions of the Act, the Commission find that the definition of agriculturist in Section 2, which has been repeatedly altered, still remains open to objection. Yet the Commission say:—"The present definition is probably as satisfactory as it can be made." It is certain that each amendment has created new difficulties, and that even now it is not at all easy to determine what was the status of a litigant, as defined in the Act, at the precise time when a cause of action arose several years ago, and how subsequent changes have affected his rights and liabilities. The Commission recommend the repeal of Section 73, which makes the subordinate judge's decision as to status final; but this might have the effect of avoiding the proceedings in many cases after they had been decided correctly on the merits. So long as the different classes of a community are allowed to have dealings with one another, different rules of adjudication cannot be applied to them without leading to injury, fraud, and perversion of the law.

The first years of the operation of the Act naturally produced a great falling off in the number of suits instituted in the Dekhan Courts. The capitalist class were virtually scared out of the courts. Even when a decree was obtained, the result was "the debtor laughs at the decree; he knows it to be innocuous." Thus "the sowkar was practically debarred by the Act from resorting to the courts." The number of suits fell, in 1880, to less than one-third of the average; in 1881 there was a recovery, but in 1882 there would have been another decline but for the great multiplication of suits for redemption. In the year 1880-81, the registered sales of land fell off about 34 per cent., mortgages with possession by about 65 per cent., mortgages without possession by about 80 per cent., and simple bonds by 32 per cent. The outflow of capital, it is plain, was most seriously checked, and, of course, most checked in those cases wherein the need was greatest. The general stagnation was indicated by a falling off of the stamp revenue in two years, from Rs. 260,000 to Rs. 180,000. The licence-tax receipts, gathered from the mercantile class, fell from Rs. 313,000 to Rs. 157,000, according to a table drawn up by Mr. Woodward. This would indicate approximately an equivalent decline, in the income of the classes paying the tax, to the extent of 50 per cent.

As soon as the money-lenders had recovered from their panic, and had learned in some measure to adapt themselves to the new situation, litigation began to resume its old course. Thus, in 1885, the number of suits against agriculturists, on simple contracts, was three times as great as in 1880. The suits for foreclosure and sale under mortgages were six times as numerous. This great increase was no doubt, in some measure, due to long suspended claims being forced into court by the six years' limitation prescribed by the Act. From 1885 to 1890, again, there was a decline of 60 per cent in the suits on simple contracts, owing to the discontinuance or extreme contraction of this form of credit. The suits for foreclosure and sale also declined materially from the highest point reached in 1885, but still amounted to nearly 900 cases. The suits for redemption, after rising to 1,600 in 1883, fell to an average of about 540 in the five years 1885-90. The aggregate of litigation under Chapter 2 of the Act shows an increase for the five years, 1885-90, over the preceding five years of nearly 80 per cent., but a large part of this increase was in suits against others than agriculturists. As intercourse has extended, and business has grown more active, the occasions for dispute amongst members of the mercantile class have become more frequent. A similar result may be observed in the district of Khandesh. The suits against agriculturists have, on the whole, been steadily increasing, but the provisions of the Act have both diminished the number of transactions, and checked resort to the courts.

The rise and fall of redemption suits under the Act shows that the influence of the artificial stimulants is as great in increasing, as that of artificial discouragements in diminishing, litigation. The redemption suits disposed of in 1884 were 3,307, and of these the mortgagee was ordered, in 413 cases, to restore the land gratis. In 1890, the number of suits had fallen to 606, and the restoration of the land gratis was ordered in 99 cases. In some of these the new law probably operated retrospectively to destroy rights fully acquired,

but allowance must be made for a certain small number of cases of usufructuary mortgages which, under the terms agreed on, had been paid off by instalments out of the produce.

On eleven years' working of the Act, redemption suits were rejected, withdrawn, or dismissed in 41 per cent. of the cases. Of those which remained, redemption was decreed in 32 per cent. of the cases, without any payment at all; in 38 per cent. of the cases from one-half to three-fifths of the mortgagees' claims were allowed; full payment was decreed in 31 per cent. of the cases; in 8 per cent. decrees were made for discharge of the debt by enjoyment of the land for a term of years. In 1890, as we have seen, a decree for recovery by the mortgagor without payment was passed in about 31 per cent. of the cases contested. This may appear an enormously high proportion; but, in the same courts, 23 per cent. of the mortgage cases not dealt with under the special provisions of the Act, were disposed of in a similar way. Agreements, in fact, are not unusual for the extinction of debt and interest, by possession and enjoyment for a term of years. On the other hand, payment in full of the mortgagee's claim was decreed in about 47½ per cent. of the contested suits, without any material difference in the proportion between the two classes of cases. Partial satisfaction was decreed in 22 per cent. of cases under the Act, and 29 per cent. of cases outside it. Of the whole of the cases dealt with under the special provisions of the Act, the creditors' full claim was decreed in 57 per cent., and part of his claim in 29 per cent. of the suits. Thus, the creditor was successful, wholly or in part, in 86 per cent. of the claims specially dealt with. The proportion throughout the Presidency of Bombay, in cases dealt with under the ordinary law, was 83 per cent. of awards in favour of the plaintiff.

It appears, then, that afterthe creditors' being almost driven for some time from the courts, an experience of ten years has enabled them gradually to come back again, with even more than average success, and so far frustrate the purpose of the Act, viewed as a measure for guarding the ryots against pressure by their creditors. The increase of suits would have been much greater but for the almost insuperable difficulties raised by the Act against the execution of decrees, and since 1886 these have been diminished. The encouragement held out to false claims on the part of the cultivators, by the remission of court fees, has no doubt still stimulated speculative suits. If we compare the fact that about 40 per cent. of the redemption suits in 1890 were abortive, with the general results of litigation, we must conclude that exemption from court fees has probably induced many false claims. A percentage of 57 of mortgagees' claims, decreed in full, indicates great moderation on the part of the courts in applying the hard terms of the Act. But 30 per cent. of decrees for redemption, without any payment at all, suggests that in a large proportion of cases the creditor has been defrauded of his just claims by the supersession of the contracts on which he relied, and the conjectural mode of making up the account between him and his debtor. The suits in which this process takes place are still generally those based on old debts. As the term of limitation is continually expiring for one after another set of these debts, or the possible growth of interest is stopped by its having accumulated to the amount of the principal, the creditor is driven into the court at all risks. He prefers a compromise on almost any terms, but this is often refused, and the chances in this class of cases are about even that the creditor will get nothing. In claims on newer debts and mortgages the creditor recovers rather more frequently than he does under the ordinary law. He has then only to obtain execution of his decree under provisions which make satisfaction, in too many cases, impossible.

It may be said that, as on the whole, and especially in reference to recent transactions, creditors do at least as well under the Act as outside it, the former evils of its operation have been cured, and the present results may be accepted as satisfactory. This, however, is not so. The creditor who has lent money, or sold goods on credit, or come to a settlement of accounts with his debtor, is still liable to have the whole series of transactions reconsidered, and the obligations arising from them readjusted, if he has to go into court. If he lends on mortgage, the terms agreed on may be wholly set aside at the discretion of a subordinate judge. What he may be awarded is, in either case, reduced in a material degree to a matter of chance. When he obtains a decree, except on a mortgage, it may be worthless. The person and the property of the debtor are secured against pursuit. In addition to the exemptions allowed by the general code, Section 21 of the Act says that an agriculturist shall not be arrested. Section 22

says that his immovable property shall not be touched unless specifically mortgaged. The alternative scheme provided for the collector's supporting the ryot's family, and getting a surplus besides, out of the land on which the ryot himself had become insolvent, has proved simply abortive. When a ryot is going down in the world, he first parts with his best land (when there is any difference), because that is the most readily sold, and realises most. By the time he becomes a judgment-debtor, his contracted holding yields no surplus having marketable value. The attachment of a ryot's standing crop, allowed by an amendment of the Act, is hazardous, costly, and wasteful. The Government's assessed land-tax is a first charge upon it; it must be guarded by watchmen; the ryot, having virtually no interest in the crop, ceases to take any care of it. The Commission propose to limit the creditor's right of attachment to half the crop. This would obviously double, or almost double, the proportional cost of execution, and, in a bad year, the land-tax might swallow up the whole residue of the sum realised. The collector cannot make a landlord's rent out of land on which a poor ryot has failed to get a living. The enactments which tell him to do so have, as the Commission say, proved, "practically, a dead-letter." Yet, they add, "the law might be allowed to stand . . . . it may of appreciable utility if the Act is extended elsewhere." The device is opposed to common-sense; it has egregiously failed in practice; yet it is to be retained as a part of the Act, on the chance that somewhere else, under other circumstances, provisions might possibly succeed, which have failed in the districts for which they were specially contrived.

The position of a mortgagee as a decree-holder is only one degree less precarious than that of the unsecured creditor. We have seen that the making up of the account is, in many cases, mere guesswork. But when the amount due is at length somehow defined, the court may direct payment by instalments. If an instalment is not paid, the court may withdraw from the creditors just so much of the mortgaged property as will sell for that sum. Where he is entitled to possession, he may be kept out of it by an instalment-order, and gain it at last only after a fresh contest. He may even be turned out of a possession given to him by the mortgage, and made to take his chance under an order for instalments. The instalment orders made by the courts are obeyed "with more or less regularity" in about one case out of five. The sums realised bear even a smaller proportion to those decreed.

The endless uncertainties and pitfalls which surround the creditor introduce a gambling element into all transactions with ryots, which is not at all compensated for by a generally high proportion of awards to claims. The weaker money-lenders having been driven into other lines of business, the competition of capital has been diminished. The remaining sowkars are in a position to exact high interest, and for their own security they must impose and enforce the most rigorous terms. In a vast number of cases in which they would, under the ordinary law, have been ready to lend on mortgage, or even on a promissory note, they compel the ryot to sell his land on a verbal promise of resale when he is able to buy at the same or an enhanced price.

This mode of dealing with land once prevailed extensively in Europe. It was used as a mode of escaping the condemnation levelled by the Church at hypothecation, and at contracts for interest on loans. The English mortgage had a similar origin; but in France, with its innumerable small holdings, sale, with a power of re-purchase, was found by experience so tempting and so ruinous to the peasantry, that, in the first drafts of the codes, such contracts were absolutely prohibited. This reform was abandoned, and further experience has since shown that a peasant who would not sell a portion out and out will yet sell his whole farm on terms of repurchase, at an absurdly low price, and become its tenant, in the hope of recovering the ownership. In this he almost always fails. He is kept poor by a rack-rent, representing a high rate of interest; and the landlord is all the while deterred from improvements by the uncertainty of his position, so long as repurchase is possible. This is an economical evil, which tends to increase as the growth of population leads to a more and more intensive cultivation; but the social and political mischief of the extension of the small proprietor, or his reduction to the state, virtually, of an *adscriptus glebæ* on the land once his own is an evil still more serious. It ought to be most serious—the example ought to be most alarming—in the eyes of those who framed the Dekhan Agriculturists' Relief Act for the purpose of keeping the peasant proprietor rooted in the soil. The Commission say that this law, "in many places, has had the disastrous re-

sult of encouraging the substitution of what are, in form at any rate, out and out sales, the sale being accompanied by a verbal promise on the part of the vendor to reconvey the property on repayment of the purchase money, and the vendor being generally continued in occupation of the land as tenant-at-will." "To such lengths is the practice carried that the Commission came across one case in which a ryot had sold a field in order to raise enough money to dig a well in it." This, indeed, might be economically beneficial if the ryot had a lease and an engagement for repurchase; but such an engagement converting the sale into a mortgage would be fatal to the capitalists' security under the Act. As a mere creditor he is helpless; as a mortgagee he is subjected to oppressive and incalculable conditions. He must become owner of the land with the former peasant owner dependent for any chance of reinstatement on his conscience and goodwill.

For these enhanced rates of interest, for the waste and worry attending mortgage, for the enforced sale of his small holding, what does the ryot gain in return? The conjectural decree, the half-principal decree, have become discredited. A judge now makes an inquiry under Sections 12 and 13 of the Act only once or twice a month, and the agriculturist has to bear the whole weight of the premium for uncertainty in return for a relief which is quite insignificant, except in so far as he can evade performances of the decree passed against him.

No part of the system introduced by the Dekhan Agriculturists' Relief Act was more counted on as a means of superseding the ordinary Courts and procuring common-sense justice than the mediation of official conciliators. This scheme, as we have seen, was adopted, but with material variations, from the French procedure. For very simple cases the friendly arbitrament of an officer, like a *juge de paix*, having some judicial training, is found useful. In France, by means of repeated adjournments, this official is able to bring a pressure to bear on an exacting creditor, which would harmonise well with the general principles of the Dekhan Agriculturists' Relief Act. But in France "conciliation," as a necessary process, is employed only within very narrow limits. Except in the pettiest cases tried by the *juge de paix* himself, it is a mere form. In the Dekhan Agriculturists' Relief Act it was made compulsory for all cases, even those for which it was wholly unadapted. The exercise, too, of a function, in which success could often be obtained only by chance or divination, was made over to a number of gentlemen uninstructed generally in the law. Common-sense and good intentions were supposed to be a sufficient equipment for functionaries who were to dispose off-hand, without formal inquiry, of the most involved and difficult as well as of the simplest cases. At first the attendance of the defendant was voluntary, but, as in more and more instances, he would not come, some of the conciliators have been armed with power to compel his appearance. Yet the horse brought to the water could not be made to drink. The men forced under penalties to submit to the process of conciliation would not, as a rule, be reconciled. The general result has been that out of about half a million of cases placed before the conciliators, agreements have been effected in only about 17½ per cent. Certificates, enabling the creditor to go to the court as a suitor were granted in about 45 per cent. of the cases: in the remainder of the cases the creditor was stopped at the threshold. Seeing what dangers the creditor would be exposed to if he went to the court as a litigant, it was a matter of course that he should consent for the most part to a considerable reduction of his claim. This has been so much gain, whether just or unjust to the contentious debtor, and in thousands of cases out of court no doubt the creditor has been driven to accept half his due or his claim through fear of throwing good money after bad by litigation under the new system. In one typical case, a creditor, it appears, acquiesced in the payment of a debt of Rs. 200 by instalments of Rs. 5 a year. It was a *reductio ad absurdum* of the system that a court should have accepted such an award and converted it into a decree, while other agreements, in themselves perhaps abusive, were refused or cancelled by the courts.

It may seem strange that when such advantages have been gained by the ryots there should be such difficulty in getting them to appear before the conciliators, and when they are brought there in inducing them to come to terms with their creditors. The reason may be that the conciliators being unpaid are independent, and not being trammelled by the artificial rules of the Act, arrive generally at conclusions distinctly more favourable to the creditors than those of the judges in similar cases. An unconscientious debtor, who hopes to escape altogether, will not easily be re-

conciled to paying even one-half. Yet very often the purpose of the institution is completely perverted. Mr. Woodward says, "The parties usually present themselves merely in order to go through the required formality of clearing a way to the court. . . . . . Agreements entered into before the conciliator are almost always settled by the parties thereto beforehand. They are used as the binding and inexpensive substitute for a new bond." More recently the District Judge of Satara says:—"The procedure before a conciliator is now merely a formal matter;" and a subordinate judge observes that the "results, in the majority of cases, are not favourable to the agriculturists, as they enable the sowkar to evade the special provisions which were intended for their benefit." In 1881 the special judge reported that "large numbers of conciliation agreements are little better than mere renewal bonds . . . . The debtor admits the debt . . . . The conciliator takes down the agreement in writing. It is signed by the parties. It is then sent to the court, and takes effect as a decree."

The cases just referred to show how astute creditors have found a means in the conciliation system itself for turning the defences raised by the Act round the defaulting debtor. By taking his debtor to a conciliator, the creditor, as the Commission report, contrives "not merely to avoid the stamp and registration laws, but also those provisions of the Relief Act which exempt land from attachment and sale in execution of money decrees." To escape inquiries into profits, mortgages with possession were converted into mortgages without possession on the creditor's terms. Simple debts were converted into mortgages. When these abuses were found out, the courts appear to have amended the Act by assuming a power to refuse or cancel the agreements, but such cases were naturally but rare.

A proportion of $17\frac{1}{2}$ per cent. of agreements effected by the conciliator implies a mere waste of time and money to one or both the parties and their witnesses, if any, in the $82\frac{1}{2}$ per cent. of abortive essays towards conciliation. In a great proportion of the $17\frac{1}{2}$ per cent. of cases an agreement would have been equally arrived at without the conciliator's mediation; this is proved by the much larger proportion of agreements in court, in suits brought without the preliminary ceremony.

Whatever advantage, then, might have been drawn from conciliation under better regulations, there appears to be good ground for what the Commission say. They "are strongly of opinion that in its present shape that system ought not to be retained." The Commission propose to convert the conciliators into official arbitrators, with authority to accept or reject agreements, which, when approved, should be subject to the ordinary stamp and registration laws. The answer to this is, *Cui bono?* If the parties desire arbitration, it is already open to them; and an award filed in a court becomes a decree, which is the most efficacious form of security. Even this, however, is open to abuse. The pliant debtor will join in a fraud on an arbitrator as well as on a conciliator or registrar of deeds. By no arrangement whatever can men be invested with the power of free agents, and at the same time guarded as if under tutelage. If they are allowed to make good bargains, they must be allowed to make bad ones within the limits prescribed to their action. The sphere of free action may be widened to some men's disadvantage; and those who will deliberately aid in defeating the law and defrauding themselves are not yet fit for complete civil liberty.

The Dekhan Agriculturists' Relief Act purports to abolish appeal (by Section 10) in all the characteristic cases under the Act. Yet, as the Commission observe (p. 32), "finality of decision is banished altogether .... Chapter VII. practically gives every party in every suit an appeal, though under another name." In the earlier years of the operation of the Act, the Special Judge and his assistants revised a large number of cases on their own motion. More recently this has virtually been given up, and revision being now exercised only on the application of a party, it is, in fact, no more than an appeal heard perhaps twice over by the assistant and the Special Judge, but irregularly and ineffectively heard, and with this evil consequence, that an erroneous ruling of the Special Judge may govern the Courts for years, and in thousands of cases before it is set right. A district judge who is dominated by some perverse legal notion, must give expression to it in some judgment which, being appealed against, is promptly rectified by the High Court, but the revisional orders of the Special Judge being final, he is not subject to this process of correction in the ordinary course of procedure. The double inquiry by the assistant and the Special Judge into a mass of cases not subject to appeal under the ordinary system involves much waste of judicial power. The Commission think that "the objections to the system appear to out-

weigh the advantages, and there is no sufficient reason why the ordinary law of appeal should not now be restored in the Dekhan." The elaborate system of inspection is pronounced "unnecessary." Yet if the ordinary system of appeal be substituted for revision under the Act, it is certain that the district judges acting, and continuing to act, on generally-recognised principles of law, will very often reverse the discretional decisions of the subordinate judges under the Dekhan Agriculturists' Relief Act. When the purpose of a law is to relieve debtors, by cutting down claims in an arbitrary way, that purpose is best effected through the prevailing influence of a single mind, thoroughly in sympathy with the law to be administered. The present Special Judge, Mr. Ranade, is a man of the highest character, and enthusiastic in his faith in the Act. He gives a consistency and vigour to its working which would be lost under a different arrangement. What is really needed is abolition of the guesswork procedure and machine-made equity of Sections 12 and 13 of the Act, and the substitution for them of a genuine and enlarged equity, resting on principles long tried and approved, and applicable, when the occasions arise, to all classes alike. If the agriculturists need special protection, it ought to be afforded by means lying outside the judicial sphere, within which mere sentiment or favour should be allowed no place.

The danger of substituting mere revision for appeal, and the unaided judgment of a single benevolent officer for the conformity with precedent, which forensic argument tends to ensure, is well illustrated by what the Commission say on p. 39 of their report, with reference to a class of cases already referred to. "In some of the earlier cases decided under the Act, the Commission found that the taking of an account resulted in a larger amount being found to be due, and a decree being given for a larger sum, than the original mortgage debt. This procedure was stopped by the Special Judge, who appears to have ruled that in no case could a larger sum than the original mortgage debt be decreed." Thus, if the account, taken in the arbitrary way prescribed by the Act, brought out a balance in favour of the mortgagor, or a discharge of interest by profits, the case was disposed of accordingly. If, after all, it brought out some balance of interest due to the mortgagee, that balance was simply cancelled. It does not appear that this ruling of the Special Judge has, as yet, been upset by the High Court. As appeals to that court are not allowed under the Act, it is only by chance that such a decision can be pronounced contrary to law. In the meantime, it must be taken as a guide by the subordinate judges, in dealing with, perhaps, some thousands of cases; and every ryot with a semblance of a case for reclaiming land as once mortgaged, is encouraged to come forward gratis and urge his claim with an assurance that he may gain, and cannot seriously lose, by the proceeding.

The special procedure provided by the Dekhan Agriculturists' Relief Act is supplemented by special provisions for insolvency. The intention of these was to make the property of the insolvent ryot available for payment of his debts, so far as it was not needed for his support. It might have been supposed that this chapter of the Act would be largely made use of, but in practice it has been a mere dead-letter. Debtors get credit, partly at least, on their personal capital of character and capacity to earn; and a ryot who shakes off his liabilities by avowed insolvency forfeits the basis of further borrowing. In petty cases, where the sum of the debts is below fifty rupees, the court can discharge a debtor from further liability on his paying as much as he can. In cases of large amounts sham creditors may come in, and the practice of charging land for pretended debts to relations and friends is far too common. A creditor, therefore, thinks he may be worse off, and can hardly be better off by driving his debtor into insolvency than by proceeding as well as he can, and as far as he can, in execution of his decree.

The Commission (p. 59) point out that an insolvent under Chapter IV. is much worse off than an ordinary debtor. Section 22 protects the land of an agriculturist against execution, unless it has been specifically mortgaged; while, under the insolvency sections, the mortgage of any part of a holding subjects the whole of it to management or sale. The ryot is not likely to throw away his shield of irresponsibility; and the creditor, taught by his helplessness in executing decrees, will not demand a declaration of insolvency against his debtor. The Commission approve of this legal impotence imposed on the creditor; for, say they, "a proper insolvency procedure gives the creditor no advantage" over ordinary execution; and "a declaration of insolvency subjects the agriculturist judgment debtor to the practical inconvenience of a total loss of credit." They appear to think it desirable

that a man, unable to pay his present debts, should still go on borrowing. Payment, enforced by a threat of insolvency proceedings, would, in their judgment, be an abuse. To other eyes, it may seem an abuse that a landowner, great or small, should be able to borrow money to save his land from confiscation on account of land-tax, to improve or stock it, and then hold the land practically free from any obligation to the creditor, to whom its retention and its value are due. The inalienableness of small holdings is an intelligible policy. Proclaim it, and lenders and borrowers alike will know on what ground they stand; but, to allow a ryot to preserve land, to improve it, even to buy it with borrowed money, and then to hold it free from liability, is an incentive to fraud that no Legislature ought to hold out. The lender, placed in such a position, will have a mortgage. The terms of a mortgage being subject to incalculable readjustment, he will prefer purchase to mortgage. The needy ryot must have money to buy seed or to pay his land-tax. He sells his land; the law allows this; in effect compels it; and so ruins the object of its ill-judged care. The ryot once become a tenant of his creditor is in general absolutely at his mercy.

The Commission propose (p. 58) that an insolvent ryot's land should be subjected to a rack-rent, and that the surplus over the Government land-tax should be periodically made over to the ryots' creditors. They admit, however, that this plan will not work in the Dekhan. By the time that a ryot becomes subject to such treatment he will, in most cases, have parted by sale with his valuable land; when seriously involved he does so now. The rack-rent would then be *nil* or next to nothing. The profits of a poor holding are a product more of the personal capital, the industry, and the patience of the ryot, than of any superiority of the soil over the poorest that pays for cultivation. Thus it is no uncommon case for land sold for arrears of land-tax to be bought in by Government at a merely nominal price. Supposing, however, that the land is really capable of affording some rent over and above the land tax, is the man who has failed as a proprietor likely to prosper in the position of a rack-rented tenant? He cannot offer any valid security for advances to enable him to replace dead or disabled cattle or to buy seed-grain or manure. It is morally certain that one attachment of his land would be followed by another; he would be driven from his holding or remain on it a mere pauper. Thus the purpose of the Government would be defeated by the direct action of the Government itself.

Of the courts of the village moonsiffs, established under the Act, the Commission say that they "have no connection with agricultural indebtedness." The Commission "attach no importance whatever to the objection that these courts encourage the institution of petty suits." Yet the procedure of these courts is not controlled by the special provisions in favour of the debtor prevailing in the ordinary courts; and facility in obtaining decrees, and thus bringing a crushing pressure to bear on poor debtors, and so to appropriate the fruits of their future industry, was the alleged mischief which called for the heroic remedies of the Dekhan Agriculturists' Relief Act. Extreme ease of recovery, as may be gathered from the evidence recently taken on the working of the English County Courts, does unquestionably favour undue credit; and as the creditors suing in a village moonsiff's court cannot be defeated by the provisions of Sections 12 and 13 of the Act, they cannot but be tempted to discount too often the personal capital of a villager, whether ryot or not, who will buy grain or cloth on terms of future payment at the huckster's own price. "A claim of a few rupees," the Commission say, "may be a serious matter to a petty shopkeeper." He ought to be able to recover it. So, too, is the money lent to pay a shop bill a serious matter to the petty money lender. He, too, ought to be able to recover it; yet the law virtually says he shall not, except on terms ruinous alike to him and to his ryot debtor. The lower we descend in the scale of transactions, the more numerous in proportion are the ignorant, helpless persons who cannot avoid debt so long as they can obtain credit; and thus the evils attendant on cheap and easy recovery increase until, in the case of accounts amounting to a couple of shillings or rupees, they outweigh the good. For those in a stage just higher, the loss of credit with sowkars drives them too often into the arms of petty dealers, who may then sue them—perhaps enslave them—for the price of goods sold at a profit equivalent to a usurious interest.

The registration system provided by the Act is condemned by the Commission, not only as practically useless, but as a means of fraud. It makes forgery difficult, but, then, forgery was not at all common; on the part of money-lenders it was certainly most rare. On the other hand, the recitals in a bond, the declarations made to a registrar, are treated as matters

of mere form. Even the money paid to the debtor in the registrar's presence is handed back to the creditor outside the office. The Commission, if not wholly consistent, appear warranted in their conclusion that as to the reality of a transaction "registration is positively harmful to the debtor, as it raises a strong presumption against him when he disputes the valuer or the payment of the consideration." They recommend that all transactions affecting land should be subject to registration, and for this there are strong reasons provided the registration be made easy and cheap. At present the cheapest form of transfer to a purchaser or a mortgagee is by a surrender and acceptance with a change of names in the land-revenue register. The Commission say they could not find that this practice existed, but it has formed the basis of some important decisions of the High Court, and a list prepared for me in 1890, by Mr. Keyser, then Collector of Satara, showed that the number of such transfers was anything but a *négligeable* quantity. A change of names in the register ought to accompany a more formal conveyance, since otherwise the transferor remains liable for the land-revenue, and thus the real owner may take the profits of the land, while he escapes what ought to be the attendant responsibility. The Commission say this mode of transfer ought to be prohibited, but the free taking and surrender of available land are essential points in the tenure of the Bombay peasant under Government, and even an oral conveyance is sufficient under the Registration Act, if accompanied by a transfer of possession.

To the provisions of the Act, which require every obligation entered into by an agriculturist to be registered, the objection has all along been taken that they checked the more simple and ordinary credit transactions, by means of which the daily business of the country is carried on. Before the Act was introduced, almost every debt of a Dekhani ryot to a money-lender was secured by a promissory note. The form of the obligation was as old as Manu. The universality of the practice was a proof of its convenience in preventing disputes. But when every petty obligation, or addition to an obligation, was declared invalid unless registered, the convenience was outweighed by a much greater inconvenience. The borrower and lender could not go several miles to a registry-office without loss of time and money. The opportunity for which a small loan is wanted will not abide delay. The charges which, of course, the borrower has to bear are inordinately heavy. The Commission admit the objections, "the trouble and expense to the parties, especially in the case of small bonds." They say that "the village registrar should be abolished," and "the registration of simple bonds should be made optional," in spite of their statement elsewhere in the report, that "this objection (*i.e.*, the hindrance to business) does not appear to be borne out by the facts. One striking result of the Act has been the encouragement it has given to loans on account," by which they mean book-debts. The obvious fact is that the great difficulties placed in the way of giving and taking promissory notes has compelled the adoption or great extension of mere book-debts. These are, under any rational system, a much less secure form of credit than the promissory note of the debtor; they give a larger opening to fraud and dispute: but the too cumbrous protection devised for the ignorant debtor has had to be discarded, like the stifling armour of the Middle Ages. Yet an entry in a ledger may as easily be contested by the debtor as fabricated by the creditor. Debtors continually allege payments which they have not made. There is an uncertainty in the position which inevitably makes the sowkar desire a higher form of security. The only one available is mortgage, and mortgage often takes the shape of sale, or the insidious form of a rent-note, under which the recalcitrant debtor is promptly evicted. Thus a vexatious registration law has co-operated with the exemption of land from attachment in execution to promote the incumbrance and alienation of small holdings, and to multiply the evictions which it was intended to prevent.

Chapter 9 of the Act imposes on the creditor receiving money from his agricultural debtor the obligation to tender a receipt for it. It also empowers the debtor to demand an annual statement of account and a pass-book. These latter provisions have, as the Commission remark, "proved practically ineffective." The ryots do not ask for settlements and pass-books, because if they were troublesome the sowkars would tell them to go elsewhere for accommodation. The tender or non-tender of a receipt is a fact depending generally on oral testimony, and hence the penal provision for not tendering a receipt has not practically been of any use. Nor does the enactment cover the case of a sowkar buying goods from the ryot and crediting him with the price. Some ryots have full confidence in their

sowkars, and generally with good reason. Some will not annoy or offend them, and thus these provisions depending on the ryot's protecting himself in ways which he thinks superfluous, and distasteful to the creditor, have been made abortive. On the other hand, when a debtor is subjected to examination under Sections 7 and 12, it is said that "agriculturists, in almost every case, plead payments, saying that the money-lenders refused to give them receipts for the same." Yet, sowkars do sometimes, no doubt, fail to endorse a receipt for payment on the debtor's copy of his bond; and as the agriculturist debtor may require this, its omission raises a presumption against him by which once more the rule meant for a blessing becomes a bane. The few suits brought for an account under Section 16 of the Act are, it appears, with few exceptions, redemption suits in disguise, brought in this shape in order to escape Court fees.

The policy of a longer or shorter period of limitation for suits has been variously viewed according to the standpoint of the observers. The Commission who originally investigated the causes of the riots in the Dekhan, thought that the terms of three years for unregistered, and six years for registered obligations were too short for the Dekhan agriculturists. The creditor, it was thought, was induced to sue earlier than he would otherwise sue, or else to insist on a new bond in order to prevent his remedy being barred. The periods were accordingly doubled for agriculturists. It was inevitable that difficulties should arise in the application of such an enactment through changes of occupation in the course of twelve, or even of six years. An agriculturist might be sued as a surety after the suit against the principal was barred. An agricultural debtor sued under the special provisions had an interest in making himself out not to be an agriculturist, just as when suing it was his interest to assume that status. The Section (72) has been three times amended, and is still unsatisfactory because of its incongruity with the general law of limitation. The other provisions of the Act are such that long credit is no longer given. Creditors practically sue within six years, and usually within three years. The Commission admit that two separate periods of limitation for different classes are open to objection, but they recommend the introduction of yet another irregularity and source of confusion by making the term for debts unsecured by a written obligation three years, and for those secured by a written obligation six years in the Dekhan. People having dealings inside the Dekhan while residing outside it, would thus be subject to a law of limitation different from that on which the enforcement of their own claims depended. The best and simplest solution would be the general adoption of a uniform limitation of six years for personal debts, whether evidenced by writing or not, and such is the opinion of some of the most experienced and capable judges.

The first economical effect of the Act was necessarily a relief, and an enrichment of the agriculturists exactly in proportion to the loss inflicted on their creditors. The Act was framed for this purpose, in effecting which, as a district judge declares, it "has been entirely one-sided, and arbitrarily favouring the debtor class at the expense of the creditor." Another judge remarks:—"Standing crops were exempt from attachment till Act 23 of 1886 was passed, and the greatest number of redemption suits, and suits on bonds . . . . . were decided on the simple plan of taking half the amount of the last bond as principal, and half as interest." "Cultivators now complain bitterly of the change which allows their crops to be attached . . . . as the money-lender can step in and carry off the whole crop except what is seized by the Collector for the payment of assessment. . . . The above powers . . . are not of much use as to contracts since the Act, but . . . . . their ultimate effect is to aggravate the disadvantages of the very class for whose benefit the Act is intended. . . . If the Courts were to attempt generally to interfere with the rates of interest in contracts . . . . there would only be an additional incentive to money-lenders to require sale deeds." The courts, in fact, interfere less than might be expected, the judges being, by experience, impressed with the badness of the security given for credits. Until Act 23 of 1886 was passed, a mere money decree was waste paper, and even a mortgage decree was good on the average for not more than 20 per cent. of its amount, if so much. Allowing, therefore, even that small debts had been unduly and unfairly exaggerated, the loss of from 50 to 90 per cent. of their outstanding debts by the small capitalists was an economic convulsion. In 1883, Mr. Woodward reported:—"The Act may be said to have accomplished its object, namely, the relief of the indebted ryots of the Dekhan, and this at the expense of the money lenders. . . . Debtors are comforted, and creditors are tormented."

The ryots, thus benefited to the extent of many lakhs of rupees at the expense of the sowkars, were further favoured by a succession of good seasons. Thus the necessity for borrowing on a large scale was for several years averted. It had been suggested that the ryots might, while they revelled in irresponsibility, be living in a fool's paradise, as money would be refused when they sorely wanted it; but this expectation has not as yet been largely realised. There has been a great activity in making railways and in other public works in the Dekhan. The field of employment has thus been greatly widened. European firms have sought more and more up country for grain and other produce. The fall in the value of silver has had a stimulating effect on the industrial classes. By these means, and by the increased mobility of the labouring population, the economical condition of the people has been maintained at a fairly high level. A subordinate Judge says that "the class which, on all hands, is admitted to be improvident and reckless, is encouraged . . . . It has not appreciably advanced in intelligence, forethought, or . . . . capacity for self-protection." Yet, some good must have arisen from the check given to borrowing in the numerous cases in which a borrower virtually pledged himself—his whole capacities—for an indefinite time by incurring a debt which he could never pay. If slavery is essentially immoral and opposed to public policy, so is the obligation by which a debtor's whole energies are indefinitely placed at the disposal of his creditor. The difference is one only of degree. But the refusal of sanction to an avowed contract of this kind implies a restriction on men's free action, which should be more exercised as the rational nature is less developed. In very petty transactions, it may fairly be presumed that extravagant interest implies dealings on a basis that the State cannot approve, though exceptions, as in the case of pawnbroking, and still more in the case of a costermonger's borrowing at 5 per cent. for a day, must be admitted. Where absolute indigence is face to face with astuteness and wealth, a set of considerations arise which do not at all apply within the region of true, free contract. This region is entered when we come to the case of a cultivator borrowing for the improvement of his farm or his stock. The Dekhan Agriculturists' Relief Act confounds the two cases, and applies to all contracts by agriculturists a rule of interference which should be strictly limited to cases of imposition and helplessness—and yet not to all contracts, seeing that, by keeping his claim above Rs. 100, a creditor may generally avoid the operation of the Act.

At the same time the Act allows sale and mortgage, though mortgage only on such terms that a creditor, in any case of doubt, will insist on sale. The inevitable result has been a great increase of sales. The capacity to stand alone had not been developed among the ryots generally by several years of prosperity under the Act. The year 1888 was one of some scarcity. The annual report of the Special Judge shows an increase in that year of bond debts by 17 per cent., in sales of 26 per cent., in mortgages of 31 per cent. over the average of the three preceding years. The increase in small loans was vastly greater than in large ones, which shows that the poorest class broke down the first. In 1889 there was again a large increase over 1888, not so much in sales as in mortgages, which exceeded by 34 per cent., and in simple bonds which exceeded by 14 per cent. even the advanced figures of 1888. The total increase of value of the instruments was 10 lakhs of rupees. The Special Judge accounts for the continued great increase in mortgages by the special value of these securities under the Act. He points out also that amongst the instruments of Rs. 20 value and less, simple bonds are eight times as numerous as the mortgages and sales, and that the proportions are almost reversed in transactions of comparatively large amount. An agriculturist can hardly get a loan of Rx. 50 without a mortgage or sale. The increase of documents is not attended with a proportionately great increase of values. This again suggests that small loans to the poorer ryots are increasing more than those of a larger amount. Since the Act of 1886 made an attachment of crops in execution possible, money-lenders have had a remedy placed in their hands which enables them to make advances on personal security with some greater degree of confidence, and to this we may probably attribute the considerable increase of simple bonds. The interest on these and on mortgages also is frequently covered by a liberal deduction from the nominal principal by way of discount, and long credits have quite gone out of fashion.

In 1890, there was again a marked increase in the number of sales and mortgages, though smaller than in the two preceding years. In simple bonds there was a decrease. The

reason for this was that there was a fairly good season. But the continued increase of sales and mortgages, and tenancy agreements, and the larger proportion of those of small value, shows that the extrusion of the small cultivators from the land, or their reduction to a state of dependence, is still going on at a continually accelerated though variable rate, in spite of, or as the Special Judge shows, in consequence of, the protective provisions of the Act. He points out, in his report for 1890, that about 25 per cent. of the borrowers of sums even below Rs. 20, are compelled to give the security of mortgage or sale, 50 per cent. have to give such security for loans below Rs. 100. If more than Rs. 50 is required, the ryot is now forced in 30 per cent. of the cases to sell his land. The ruinous rent-notes have multiplied by many thousands. It is plain, then, that now, as when the Secretary of State wrote on the subject in 1878, "the Dekhan ryots . . . . . . are entirely without capital, and are driven, on the first bad harvest, into the hands of the money-lender. . . . . This fact has created the system of borrowing at high interest, which prevails so largely . . . . and has made the existence of a money-lender, in a Hindoo village, as essential as that of a ploughman." The demand of land-tax is inevitable, invariable, inexorable. Recourse to the money-lender being thus, under the existing system, indispensable, every obstacle placed in the way of making use of his capital, every uncertainty of recovery, must necessarily raise the rate of interest. Sale and mortgage, and tenancy rent-notes, being allowed, and these being the only means of effectively binding the land, it was inevitable that they should greatly increase. The Commission of 1892 say that, "a large and increasing area is still being annually transferred from the cultivating to the trading and other classes; but they are of opinion, that generally speaking, it is impossible to attribute any of this increase to the working of the Act." Yet, elsewhere, they say, "that the law has led to some extension of mortgage-debt cannot be doubted," and again, "in many places it has had the disastrous result of encouraging the substitution of what are in form, at any rate, out-and-out sales, the sales being accompanied by a verbal promise, on the part of the vendor, to reconvey the property on repayment of the purchase-money, and the vendors being generally continued in occupation of the land as tenant-at-will." The extension of the mortgage debt can be judged from the figures supplied by the Commission themselves. Thus, in the district of Poona, the mortgages with possession registered, in 1883, of areas under five acres, were 2,549; in 1891 they were 6,358. The mortgages of such areas without possession, in 1883, were 298; in 1891 they were 1,357. The sales of these small areas, in 1883, were 629; in 1891 they were 1,690. There was a similar, though somewhat varying, increase in the other three districts under the Act. In all, the transfers of areas exceeding 100 acres are insignificant, the hundreds or thousands of mortgages and sales are of petty holdings, the prior owners of which are thus, for the most part, made landless men — the very evil which the Act was to cure. The preference of the people for mortgages with possession is invincible, in spite of the hard terms imposed by the Act, but the surest weapon of oppression is a rent-note enforced or enforcible through eviction by a Mámlatdár. The Commission think that, "for men of good credit, the terms must be somewhat easier than they were." What their tables show is that, while some few mortgage debts bear but 6 per cent. interest, the mass bear from 12 to 24 per cent. interest. In some cases the rate rises much higher. The excess over 6 per cent. must be regarded as a payment for uncertainty and trouble. The Commission say "the rates depend largely on the state of the market and the nature of the security;" the state of the market is such that capital is forthcoming at 6 per cent.; the security under the Act is so bad that a double or triple rate is exacted in the immense majority of cases. The courts allow these enormous rates, because they are aware that they are usual, which proves that a lower remuneration will not, in most instances, under the present system, draw forth the requisite capital. Yet it is plain that borrowing at such a rate virtually closes up a large field of improvement in agriculture.

If we compare the economic progress of the districts under the Dekhan Agriculturists' Relief Act, during 10 or 12 years with either that of Khandesh, lying to the north, or of Bijapur, lying to the south, the result is all in favour of the unprotected districts. Thus the portion of the whole cultivated area, devoted to wheat and other exportable crops, is in the four districts under the Act about 15 per cent.; in Khandesh it is 55 per cent., and in Bijapur

33 per cent. In Khandesh the minatory notices issued for the payment of a lakh of land-revenue are about one-third of what they are in Poona, and one-fourth of those issued in Ahmednagar. In Bijapur the collector consulted his assistants in charge of parts of the district. Two of them had had experience of the working of the Dekhan Agriculturist's Relief Act, and both opposed its extension to Bijapur. One of them says :—"I have seen something of the working of the Act in the Ahmednagar district, and the general result seemed to be, that while the ryots got free from part of their debt, their credit was ruined, and the sowkars impoverished, without much advantage being gained in any way." "In Hungund and Bagalkot [talukas under this officer's charge], the condition of the ryots is excellent." Mr. Woodburn, fn 1889, reports of Khandesh and Bijapur, that "the condition of day-labourers has scarcely ever been better." This denotes an increasing employment of capital in cultivation. Both in Khandesh and Bijapur there has been a considerable agglomeration of land in the hands of the more wealthy cultivators, just as in the districts under the Dekhan Agriculturists' Relief Act. The new conditions of economical cultivation make themselves felt in one district as in another.

In his report of 1889, Mr. Woodburn compared the state of things existing in the four Dekhan districts with that of five other selected districts. Some of these comparisons present results of an apparently contradictory character, but this comes out clearly, that, in the Dekhan districts, there has been a relative decline in Licence-tax, Income-tax, and Stamp Revenue, which may indicate stagnation of trade and decline of the middle class. He makes out the indirect loss to Government, arising from the operation of the Act, to be Rs. 311,200 a year. He computes at Rs. 142,740 a year the direct extra charge to Government of administering the Act. The two sums together come to more than 4½ lakhs of rupees. This represents the interest on a crore, with a handsome surplus to employ as a sinking fund. If a crore of rupees had been employed in establishing a sound credit system, would not the effect have been better than the very qualified results that have been attained? It would have been perfectly fair to emphasise the equitable rule which gives relief in cases of fraud, surprise, and misunderstanding. So far Section 12 of the Act is sound, if in some measure superfluous. To relieve the debtor from a burden which had been consciously accepted, and at the invitation of the law, the proper method was that which has been pursued, under similar circumstances, on the Continent of Europe. There, in some regions, the usurer has been banished by a sound organisation of credit, resting on the co-operation of the people themselves, and when we find that even now only about one-third of the mortgages in the Dekhan stand at less than 12 per cent., while in another third the interest ranges between 18 and 75 per cent., it is plain that usury has not been stamped out by the Dekhan Agriculturists' Relief Act. It has been qualified only by the discretion of readjusting the terms of all contracts, which reduces the result to complete uncertainty. For this the borrower must pay, and unhappily it is the intelligent and energetic ryot who has to pay for the reckless and unprincipled one.

Sir William Wedderburn, several years ago, published a pamphlet on "Agricultural Banks for India," which pointed out how the cost of interest might be reduced by at least 50 per cent. He proposed to build on the lines of joint-stock enterprise, favoured by Government, and there can be little doubt that even in this way, the terms of borrowing being made far easier, the condition of the agricultural proprietor could be immensely improved. Eight or nine years ago, in a series of papers in the *Times of India*, which were afterwards republished under the title of the "Organisation of Credit in Europe and in India," I gave a description of the Schulze-Delitzsch and Raiffeisen systems of mutual credit, by which the poorer classes, especially in Germany and Italy, have contrived to find and dispense large funds in the requisite financing of both small manufactures and agriculture. Progress has been made in the years that have since elapsed, and the results are set forth in a book recently published, called "People's Banks." It is to such institutions, rather than to direct Government aid, that I would look as a means of social regeneration in India. I say social regeneration, because in India and in the Dekhan, at least as much as in Europe, the moral factor is the most important one, even in the economical problems, while the economic system reacts with intense force on the character of the people. A study of the working of the co-operative societies in Germany or Italy shows that, by mutual vigilance and social pressure, the worthless members of the borrowing-class are weeded out, while those who, by nature, would hover on the verge of thrift-

lessness, are kept on the right side of the boundary, and preserved as honourable and steady members of the industrial community. No system of takávi advances by Government, no banking on the mere principle of profit-making, can be compared for stimulating efficacy with the associations in which every member is concerned to support and improve the character and capacity of all his fellows. Such associations, at their inception, need a guiding and energising influence. They need almost no external capital. The large extent of land acquisition, the ever-growing amount of loans on mortgage by ryots themselves in the Dekhan, prove that there is money enough within the class were it but properly utilised. There could be no more profitable exercise of practical philanthropy than in the organisation of mutual loan societies in the Dekhan, by which the moral, as well as the monetary capital of the industrious Mahrattas could be made more fruitful in wealth and comfort to its possessors. I have discussed the subject at length in the pamphlet to which I have referred. It deserves a paper all to itself, and I commend it as a topic to those amongst my audience who, being furnished with personal experience, know how to make the teachings of European experiments available for the benefit of India and its people.

DISCUSSION.

Dr. A. D. Pollen, I.C.S., said it would be almost impossible, with the brief time at his disposal, to attempt to follow the learned reader of the paper into all the particulars of the very comprehensive indictmen he had levelled against the piece of remedial legislation known as the Dekhan Agriculturists' Relief Act. But as he had the honour of being associated, in the capacity of Special Judge, with the administration of the Act for the first six years of its operation, and, during the greater part of the time the Chairman presided over the Bombay Presidency, he should like to make a few general remarks in bar of judgment. The Chairman had divulged a secret, though it was perhaps only an open secret, that the reader of the paper had been the foremost opponent and the unsparing critic of this measure from the moment of its earliest inception, and the very interesting paper they had now heard showed, at any rate, that he was entitled to credit for consistency. Naturally, he was not able to see much good in a measure which, from the first, he had denounced as hopelessly bad. At the same time, with all deference, he (Dr. Pollen) ventured to think that, in its actual operation, the Act had not proved to be the complete failure and fiasco which had been depicted. He did not mean to say that the Act was ideally perfect: no such attempt at legislation ever was. When he first commenced to study its provisions, with a view to superintend its administration, he found it to contain so many cruxes and imperfections of detail that at a very early stage—about May or June, 1880—he was compelled to submit, for the consideration of the Government, a formidable list of amendments which he deemed absolutely necessary. Some of them met with ready acceptance; others were ignored at the time, but of these not a few had been since adopted in the recommendations of the Commission which sat only last year in Poona. His proposals for the amendment of the Act were submitted to, amongst other authorities, the High Court of Bombay, of which Court, at the time, Sir Raymond West was a distinguished judge. He was good enough to publish a pamphlet in which, while admitting that the Act contained some possible germs of good, he made short work of his (the speaker's) proposals by observing that perhaps the best method of amending the Act would be its complete repeal. Sir Raymond's views, fortunately, as he thought, for the Dekhan peasants, did not meet with approval at that time; and the Act, having been three times amended, and having now been in operation for 13 years, had fulfilled to a very considerable, if not to their full, extent the expectations of those with whom it originated, foremost amongst whom were Sir Richard Temple and Sir Theodore Hope. The Bombay Government, from the very commencement, watched the practical working of the measure with very great care, and on two different occasions appointed special officers to inquire and report. They had been referred to that afternoon, and, if his memory served him, the general tenor of their reports was distinctly favourable to the Act, although no doubt isolated passages could be picked out by an adverse critic in favour of his arguments. Again, in 1885, the whole subject came up for review before the Bombay Government, which at that time was composed of Sir James Fergusson, and his two honourable colleagues, the late Sir Max Melvill and Sir James Peile. Those eminent officials were practically unanimous, and minuted strongly in favour of the Act. They submitted a dispatch in that sense to the Secretary of State for India, recommending at the same time certain amendments, the most notable of which was that standing crops, which had previously been exempted from liability to attachment and sale in execution on simple money decrees against agriculturists, should in future cease to be so exempted, a concession made in the interests of creditors. The Secretary of State adopted the views of the Bombay Government and sanctioned their proposals, and, moreover, called for a further report whenever additional experience had been gained. When the matter again came up for review, some years later, it did not find the Bombay Government quite so unanimous as on the previous occasion. The Revenue

Member of Council was as strongly in favour of the Act as his predecessors had been; but the Judicial Member of the Council was then Sir Raymond West himself, and he was as strongly opposed to the Act as he had been before. The Governor, Lord Harris, had only recently arrived, and, although not opposed to the Act, he was bound to maintain more or less reserve. The result of those divided counsels was that the Government of India determined to appoint a strong committee of distinguished judicial and revenue officers, specially selected for the purpose from the different provinces of India, and along with them was associated a native gentleman of Poona, who had been a member of the Viceroy's Legislative Council. That Commission was presided over by Mr. Neill, the Judicial Commissioner of the Central Provinces. It sat for nearly six months, during which time it travelled through a greater part of the affected districts, examined a large number of witnesses, a vast mass of records and cases decided under the Act, and adopted every means of ascertaining how the Act had worked. The result of the labours of that Commission were embodied in a long report, issued only a few months ago; and that report furnished a most triumphant vindication of the principles and general policy of the Act. The Commission had not been blind to many imperfections in details, and had made various suggestions for their amendment very similar in character to those he himself unsuccessfully advocated many years ago; but the main provisions and cardinal features of the Act it had stamped with unqualified approval, not only recommending their retention in those districts where they were already in force, but their extension to other parts of India, where similar problems presented themselves for solution; and those were the features which had been most attacked that afternoon. He would suggest that a measure which had commanded so large a share of approval at the hands of distinguished and impartial critics, could not be such a bad measure in its principles and results as the author of the paper would have them believe. He thought that Sir Raymond West had not brought into sufficient prominence the various evils the Act was designed to mitigate. For several years before the passing of the Act, the condition of the agricultural population of the Dekhan had been most deplorable. From year to year the reports of the collectors teemed with the most melancholy pictures of the deep distress, poverty, and indebtedness of the ryots, and of grinding exactions of the creditors, and also of the harsh and unsympathetic action of the civil courts. As a matter of fact, the ryots obtained very scant justice from the courts under the old system. Their rigid and mechanical action were found to unduly favour the creditors. The courts proceeded on the assumption that the parties before it were on equal terms, that they were equally intelligent, and that the sums named in the bonds represented debts really due, all of which assumptions were notoriously incorrect and untrue. In this way, the land in the possession of the peasantry was found passing away from their hands, not by private sale, but by the compulsory process of judicial sale, into the hands of foreign usurers, who, not being able to cultivate it themselves, used to retain their former proprietors as their rack-rented tenants or bond-slaves. At last matters came to such a pass that the ryots took the law into their own hands. Agrarian crime became rife; in many parts of the district money-lenders were murdered or mutilated; and even now it was no uncommon sight in the Dekhan village to see a respectable sowkar minus his nose. Their houses were broken open and pillaged; their books of account and money bonds were burnt; agricultural produce was set on fire, and the country was gradually becoming in a very lawless state. The Bombay Government then appointed a Commission, of which Sir James Richey was a member, which issued a report that was very melancholy reading. The Commissioners suggested various remedies, many of which had since been embodied in one form or another in the Relief Act of 1879. The most important feature of the Act was the large powers of discretion granted to the civil courts of revising contracts in an equitable spirit, and he thought the courts, on the whole, had exercised that discretion with great ability and moderation. He watched them carefully for years, and although doubtless occasional mistakes were made, and individual cases of injustice to creditors did occur —which mistakes had been made the most of and taken as representing the general treatment—the results of the Act had been beneficial, and less injustice was done now under the present system than under that which preceded it. He wished he could go more fully into details, and point out paragraph by paragraph the other side of the picture to that presented by the reader of the paper, but time did not allow. He hoped he had said enough to show that notwithstanding its many imperfections and ambitious efforts to do too much, the Relief Act, like a well-known Scriptural personage, was not so black as it was painted.

Sir JAMES LYALL, K.C.S.I., said that he came to the meeting with no intention of speaking, but being invited to speak, the only thing which occurred to him was that the reader of the paper, at the beginning, stated that whenever you granted proprietary rights to people like the peasantry of India, experience showed that all the thriftless ones and all the weaker ones, sooner or later, were swept away, and their places taken by more active and energetic men. If that were so, there might be something to be said for it, but the fact was that their place was not taken by more active and energetic men, but by a different class of men altogether—a class who did not cultivate the land themselves, but who rack-rented the tenants underneath them. Though, therefore, the remark of the learned reader of the paper sounded true, and would be true, if the people concerned were a different set of

people to what they were, he ventured to think it fallacious, when applied to the peasantry of India; and the same criticism would, he thought, be true of many of the other remarks of Sir Raymond West; they would be good arguments, if the Indian peasantry and money-lenders were not the people they actually were. The Deccan Act was an attempt to make our legislation fit the actual conditions of the people concerned.

Sir William Wedderburn, M.P., said they were much indebted to Sir Raymond West for the very interesting paper he had read, which, from his learning, his independence, and his experience, he was particularly well qualified to prepare. The Dekhan Agriculturists' Relief Act was one for amending the procedure of courts, and Sir Raymond West was of opinion that it was bad in principle, and had worked badly. His own complaint was, perhaps, more against the system it was meant to amend, than the intentions of the Act itself. They had introduced into India a system of civil courts suited, perhaps, to the commercial nations of the West, but eminently unsuited to the peasant cultivators of the Dekhan and the rest of India. The result of that had been pointed out by the reader of the paper, namely, an enormous development of credit by which the ryots were enabled to obtain large advances from the money-lenders. His belief was that the assessment of the land-tax was much too heavy in those districts, and that if the money of the money-lenders could be traced, it would be found to have reached the coffers of the Government. When seasons were bad and difficulties arose, the ryots began to feel the pressure both from the Government and from the money-lenders, and as the Government was an irresistible force, the agrarian disturbances were directed, not against the Government, but against the money-lenders. As long as this credit had been useful in getting in the land revenue, it was not objected to by the authorities, but after these disturbances the whole matter came under review, and this Act was passed which struck at the credit of the ryot, and, in point of fact, prevented the money-lender collecting his debts; though, at the same time, the Government took no steps to moderate the rigour with which they collected their debts themselves from the ryots. His complaint was that the whole system was unsuited to the condition of these ryots, and that the Relief Act was based on a wrong idea. The idea was that the money-lenders defrauded the ryots, but he thought it was satisfactorily established that no large amount of fraud took place. The real fact was, that the ryots were very poor, and so completely in the hands of the money-lenders that they were willing to sign any bond; and there was no object in forging bonds, because what they had signed already were far more than they could pay. His belief was that the whole system being unsuitable to the peasant cultivators, they ought to go back to the old native system of arbitration or Pancháyat by which the debts used to be collected under the Peishwa's Government. They exhausted every form of arbitration, and the judges only came in at the very last, when no settlement could be obtained. He might mention that some years ago, at several meetings in Poona, under the auspices of local associations, a very good scheme was arranged, by which permanent arbitrators were to be appointed in various parts of the district; all cases were to come up before them, if possible, to be settled, and if they could not settle them, the subordinate judge was to go round and, sitting with those arbitrators, settle those disputes once for all. This scheme was approved of by the representatives both of the ryots and of the money-lenders, and he very much regretted that the Government did not see its way to give it a trial, and to go back to the old custom of the country in which he, as a Radical, but, at the same time, a Conservative, most believed. This system was introduced, to some extent, under the form of conciliation in the Dekhan Relief Act; but he did not think it was developed in a way sufficient to give it a fair chance. He should be very sorry to see it on that account withdrawn, but would rather see it developed, and made the basis of a fresh arrangement. He was glad Sir Raymond West had given his powerful support to the scheme of agricultural banks. The Government took a great deal of trouble in India to levy taxes and get money out of the ryot, but he thought they ought to take some steps to look after his prosperity. He was the milch cow of India; and they were very ingenious in schemes for milking the cow, but they ought to look a little more to feeding it. Then milking would come easy enough. This scheme of agricultural banks, which would supersede the usurer in a reasonable way, was the direction in which he should like to go, especially as it had all those advantages which Sir Raymond West had pointed out. This Act was a method of collecting debts, but the real difficulty was the excessive poverty of the ryot. You could not get blood out of a stone, and no amount of good arrangement in procedure would get money out of a debtor if he had none. The real remedy was to follow out patiently and diligently schemes for improving the condition of the ryots, and as regards procedure, instead of adopting Western methods, to restore the Eastern, which were more suited to the people.

The Chairman observed that after what had been said by Sir William Wedderburn he felt bound just for the moment to point out that what he was arguing for was a departure from a long-settled purpose. What he called Western methods was rather intended to be a restoration of good Eastern methods, and an improvement upon them; and in advocating such a great retrogression he was at issue with the great body of Indian Governors and Administrators—in fact he was rather *contra mundum* in his arguments With

egard to the working of the Act itself he had the leliverance of the Secretary of State on this case, n 1884, when it had been in operation five years, and ıfter having all possible evidence before him, and his was what Lord Kimberley said: "It is shown hat cultivation has extended in area since the Act became law; that it has not fallen off in quality; that the revenue is realised as effectually as ever; that it has ordinarily been paid from the produce of land, not by borrowing, or by the sacrifice of agricultural stock, and that in those districts which had suffered at once from short harvests and low prices the people have struggled against the difficulties of the season at least as successfully as they did before the Act was passed. It is the opinion also of the officers who possess an intimate knowledge both of the working of the law, and of the condition of the people, that the moral effect of the law has been good, that it has encouraged thrift, prudence, and mutual help. Finally, it is confidently stated that the opinion of the ryots themselves is altogether in favour of the Act; that they have never been more contented than at present; that the people of the locality in the vicinity of the four districts desire to be brought under the operation of the Act, and that natives of experience believe that in another ten years the Act will effect a striking improvement in the material condition of the agricultural classes." Certain improvements were made in the Act as defects were discovered; and in the instructions of the Commission which had reported, the Governor-General in Council said that not only had the operation been one of interest to other provinces, but the Government of India had now before them definite applications from the Lieutenant-Governor of the Punjab for legislation, substantially on the same lines for that province; and the Chief Commissioner for the Central Provinces, in November, 1889, submitted proposals for the constitution of special courts empowered to go behind the bond, and so on. They would all await with interest the result of the recent inquiry. He would conclude with proposing a cordial vote of thanks to Sir Raymond West who, he was sure, was too gallant a controversialist, and too much a man of the world, to quarrel with those who did not altogether agree with him.

The vote of thanks was carried unanimously.

Miscellaneous.

THE AUSTRALIAN WINE INDUSTRY.

The *Times* publishes, from a special correspondent, a detailed description of the Australian wine industry. Writing from Adelaide, the correspondent says of South Australia "that, as the capacities of the soil and climate for wine-growing are more fully realised, the area under vines tends to increase rapidly year by year." In 1882, there were about 5,000 acres under vines; there are now about 15,000 or 16,000, and of these no less than 3,000 or 4,000 were planted last year. In 1887, the quantity of wine made in the colony was 510,000 gallons; last year it was 1,048,170. The average yield of an acre will vary from one to three tons of grapes, according to the kind of vine and nature of the soil; and a ton of grapes will give from 110 to 150 gallons of juice. It is easy to see, therefore, that the million of gallons of this year will not take long to double and treble itself under the present extension of planting. With the stimulus of irrigation in Victoria, the increase which is taking place in production in this colony is repeating itself there. New South Wales is also a wine-producing colony, and the question of what is to be done with the wine is becoming an important one to Australian industry. Local consumption is steadily increasing, but it is evident that the consumption of 3,500,000 people, even supposing the habit of wine-drinking is to be much more general than it is, would be insufficient for such an area of production. In South Australia, the figures for the last five years show that, in 1887, with a production of 510,000 gallons, the export was 89,000 gallons. Last year, with a production of over 1,000,000 gallons, the export was 325,041 gallons. This is satisfactory, in so far as it shows that, in proportion to production, the export trade has increased. Still, it is far from sufficient, and wine-makers are left with very considerable stocks on hand. Victorian figures give a total production for 1892 of 1,997,593 gallons, with a total export of 222,324 gallons. The wine-maker of both colonies, therefore, feels that he has still before him the business of opening the markets of the world. Excellence of manufacture is purely a matter of time, demand, and expert knowledge; and there is no reason, in the Australian growers' opinion, why Australia should not reap in her wine trade, as in other producing industries, the natural benefits of her immense extent of soil and her reliable climate."

The correspondent goes on to say:—"It would not, I think, be claimed that the very best vintages of France, or Germany, or Portugal have as yet been rivalled; but, if we set aside some dozen or so that could be named, Australian wine-makers would not shrink, even now, from competition with a chosen dozen of the second rank. The nature of the wines is probably well known, even in England. The tendency of the clarets is towards a richer, more fruity, and Burgundian flavour than the critical lover of good Bordeaux would approve. The Burgundies, like the white wines, incline to suffer from excess of alcohol. Ports, judged by the European standard, are best able to sustain exact comparison. Champagne—though I am told that it has been made with great success—appears to be less generally made than any of the other wines; and I have been unable to obtain any reliable opinion as to how it compares with the sparkling wines of France."

The writer adds:—"The advantage for the wine-consuming public of developing and tapping large wine-producing districts in the southern hemisphere, with which to supplement the supplies and counterbalance the uncertain seasons of European vineyards, would evidently be great, if the first difficulties can be surmounted—as they undoubtedly may be by careful manufacture—and the full benefit be drawn from the favouring conditions of nature. A practically illimitable area, in a reliable climate, ought to offer such opportunities to an intelligent population as would result in largely increasing the world's supply of one of its most highly-valued luxuries. But the characteristics which are presented by soil and climate are not the only ones which present themselves for the consideration of the Australian wine-grower. If land is much cheaper to him than to his competitor in Europe, labour is dearer. The expert pruner in France does for 2s. a day the work for which the untrained Australian hand expects to receive 6s. "The question is, in the long run, entirely one of quality. If the wine is good enough, it will fetch a remunerative price. But in order to present it to the English public in a condition in which it may be fairly judged, some little organisation is required. The journey from Australia, which involves passing through the tropics and arriving, perhaps in mid-winter at the London docks, is trying to the best and soundest wine. Much of the wine which is sent away is insufficiently matured. It may be neither good nor sound, and upon arrival in England it is totally unfit for immediate sale. To put it on the market in its sick condition is to discredit a great deal of better Australian wine and to strengthen prejudices which are already, in the matter of wine, always difficult to overcome. The evil effects of the voyage can be quite easily averted by sterilisation, a process often resorted to in the case of European wines, or by the employment of the cool chambers already so largely used for the conveyance of perishable produce. But it is felt that from every point of view a great deal may be gained by the establishment in London of colonial wine depôts for the reception and treatment of Australian wine. The proposal is, not to store the wine in bond, but to pay duty and keep it subject to inspection and purchase by the trade. All wine received at the depôt will be tested, and reported upon, and, if necessary, handed over to a qualified cellarman to be treated as it may require. By this means the wine will not only be brought more fully and easily to the notice of the English trade and public, thus extending the at present too limited export connection of Australian firms, but it will be saved from the damage done to its reputation when inferior sorts are suffered to go upon the market in an unsound condition. The South Australian Government has consented to lead the way in establishing the first of these colonial wine depôts. It will remain for the wine-growers' associations of the colony to supplement it by the formation of a purchasing company, which might still further improve the reputation and chances of Australian wine by buying up the better colonial stocks and maturing them for export."

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, JUNE 13...Gas Institute, City-hall, Victoria-street Belfast, 11 a.m. Annual Meeting. President's Address. Reading of papers and discussion.

Asiatic, 22, Albemarle-street, W. 3 p.m.

Medical and Chirurgical, 20, Hanover-square, W. 8½ p.m.

Photographic, 50, Great Russell-street, W.C., 8 p.m. 1. Mr. W. Taylor, "The Constructison of Interchangeable Lens-screw Fittings." 2. Dr. C. P. Goerz, "Exhibition and Description of a New Anastigmatic Lens."

Anthropological, 3, Hanover-square, W., 8.30 p.m. 1. Dr. Francis Warner, "Deviations from Normal Development among 50,000 Children." 2. Dr. T. S. Clouston, "Developmental Aspects of Criminal Anthropology." 3. Mr. Osbert H. Howarth, "The Rock Inscriptions of Sinaloa (West Coast of Mexico), and Evidences of their Asiatic Origin." 4. Mr. E. H. Man, "The use of Narcotics by the Nicobar Islanders." 5. Mr. Osbert H. Howarth, "Exhibition of Pottery and Crania (Acolhua and Toltec), from a Tomb recently opened at Xico, Valley of Mexico."

Colonial Institute, Whitehall-rooms, Whitehall-place, S.W., 8 p.m. Mr. F. C. Selous, "Incidents of a Hunter's Life in South Africa."

WEDNESDAY, JUNE 14...Gas Institute, City-hall, Belfast, 10 a.m. Annual Meeting. Reading and discussion of papers continued."

Royal Literary Fund, 7, Adelphi-terrace, W.C., 3 p.m.

THURSDAY, JUNE 15...Gas Institute, City-hall, Belfast, 10 a.m. Annual Meeting. Reading and discussion of papers continued.

Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, 8 p.m. 1. Dr. Stapf, "The Botany of Mount Kini Balu." 2. Professor W. A. Herdman, 'Notes on British Tunicata." Part II. 3. Miss A. L. Smith, "Description of a new plant constituting a new genus and provisionally referred to Melastomaceæ." 4. Mr. Scott Elliot, "African species of the genus Ficus." 5. Miss M. Benson, "Contributions to the Embryology of the Amentiferæ."

Chemical, Burlington-house, W., 8 p.m. 1. "Contributions to our knowledge of the Aconite Alkaloids;" (vi.) Prof. Dunstan and Mr. F. H. Carr, "Conversion of Aconitine into Isaconitine;" (vii.) Prof. Dunstan and Mr. H. H. D. Jowett, "Modifications of Aconitine Aurochloride." 2. Mr. S. U. Pickering, "Properties of Strong Solutions." 3. Mr. S. U. Pickering, "Note on the Stereoisomerism of Nitrogen Compounds;" and other papers.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. Phené, "The Classification of Artistic Design, and Geographical Extent of Pelasgic and Emplecton Construction."

Historical, 20, Hanover-square, W., 8½ p.m. 1. Mr. George Hurst, "Pilgrimages." 2. Mr. I. S. Leadam, "The Inquisition of 1517: Inclosures and Evictions." Part II.

Numismatic, 22, Albemarle-street, W., 7 p.m. Annual Meeting.

FRIDAY, JUNE 16...Quekett Microscopical Club, 20, Hanover-square, W.C., 8 p.m.

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FRIDAY, JUNE 16, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirty-Ninth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurers' statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 28th June, at 4 p.m.

(By order of the Council),

Henry Trueman Wood,

Secretary.

CONVERSAZIONE.

The Society's *conversazione* will take place at the Imperial Institute, South Kensington (by permission of the Council of the Institute) on Friday evening, June 30, from 9 to 12 p.m.

The reception will be held from 9 to 10 p.m. in the vestibule, by Sir Richard Webster, Q.C., M.P., Chairman, and the Members of the Council of the Society.

Each member is entitled to a card for himself, which will not be transferable, and a card for a lady. A limited number of tickets will be sold to members of the Society, for the use of their friends, at a charge of five shillings each, if purchased before June 24. After that date, the price of tickets will be raised to seven shillings and sixpence.

Tickets can be obtained on personal application at the Society's House, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, and must be signed by the member to whom it is issued.

Promenade concerts will be given by the band of the Scots Guards in the West Gardens, which will be specially illuminated, and by the band of the Royal Artillery, in the Indian Pavilion, from 9.15 p.m.

A selection of music will be performed in the vestibule, commencing at 9 p.m.

The principal galleries will be open, including those containing the collections illustrating the natural resources of the Colonies and India, Indian art metalwork, &c.

Light refreshments will be provided at the large buffet in the North Gallery, the Ceylon Kiosk in the Central Gallery, and the kiosks in the gardens.

As part of the entertainment will be in the open air, visitors are advised to retain their hats, &c.

Admission will be by the main entrance in the Imperial Institute-road.

Those travelling by railway to or from the Imperial Institute will be allowed the free use of the District Company's subway, which leads from South Kensington Station to within a few yards of the Imperial Institute-road.

Programmes will be distributed on the evening.

The cards of invitation have been issued to members.

Chicago Exhibition, 1893.

COLLECTION OF GUIDE-BOOKS, &c.

The Royal Commission have formed a collection of Maps, Guide-books, Photographs, Railway and Steamship Guides, Programmes, and other printed matter likely to supply useful information to exhibitors at, and visitors to the Chicago Exhibition.

The collection is placed in the library of the Society of Arts for reference. It is open to members of the Society, exhibitors, or their agents, and others interested.

HANDBOOK OF REGULATIONS.

The final edition of the "Handbook of Regulations and General Information" connected with the Chicago Exhibition has been printed, and can be had gratis on application to the Secretary of the Royal Commission, Society of Arts, John-street, Adelphi. The Handbook contains lists of the Commission, of the various Committees, and of the Colonial Commissioners, Synopsis of the Classification, General Regulations, Regulations of the British Section, Traffic Arrangements and Customs Regulations, Descriptions of the various Buildings and Departments, an Abstract of the McKinley Tariff Rates, description of Chicago and the Exhibition, and particulars of the Railway and other routes to Chicago.

Proceedings of the Society.

APPLIED ART SECTION.

Tuesday, May 30, 1893; GLEESON WHITE in the chair.

The paper read was—

AMERICAN SILVERWORK.

By H. TOWNSEND.

While I felt not a little honoured by the request which was made to me a few weeks ago in this place, so redolent of the memories of men famous in arts and letters, I felt more than usually diffident at the prospect of displaying my own shortcomings. However, I can only trust that the interest of the subject upon which I am to speak will outweigh the obvious unworthiness of the speaker. Indeed, if I succeed in carrying out my own intentions I shall appeal to you, not so much through my own inherent virtue of eloquence, as by being the means of a display of that virtue in others.

I am going to talk to you to-night about the silverwork of America, and it will not be, I take it, unfitting, before plunging *in medias res*, if I endeavour to briefly and succinctly lay before you the reasons which lead me to believe that the subject is one which entitles itself to be considered, even at such length as that at which I propose to treat it. Nothing is more apparent to any one who, like myself, is addicted to the bad habit of staring in shop windows during the progress of his daily walks abroad, than that during the past ten years the employment of silver for the fashioning of all articles of household use or personal adornment, has been largely on the increase. We are, in fact, living in a veritable "silver age."

Into the economic causes which have led to this vastly increased use of what we are accustomed to call a precious metal, this is not, I conceive it, the exact place, nor am I a fitting person, to inquire too closely. It is, however, apparent that the enormously increased output of silver from the newly discovered mines in Colorado, and other of the Pacific States of America, has played the chief part in the increased and increasing use of the metal in question. Since the discovery of America, for instance, silver has been produced to the value of no less than £14,000,000,000, of which only £3,000,000,000 can be accounted for in existing coinage. This means that £11,000,000,000 worth have either been used in the arts, or practically lost to us. This enormously increased output, a great part of which has, as I have said, taken place in comparatively recent years, has naturally affected the intrinsic value of the metal; that is to say, its ratio to-day as compared with gold, is only about half of what it was 500 years ago. The Roman ratio was, in the early days of the Republic, 10 of silver to 1 of gold, and subsequently increased to 12 to 1. The discovery by Spain of the mines of Potosi raised it to 13½ of silver to 1 of gold, at which it remained until the end of the 17th century, when the Portuguese practically governed the rate, and raised it to 16 to 1. In the last few years it has approached more nearly to the ratio of 20 to 1 than has ever been known in the world's history. This relative cheapness of the metal has, doubtless, led to its more general introduction into our daily life. Be the cause what it may, however, the fact is certain, that one cannot walk down Bond-street or Regent-street without seeing, in every other shop window, trinkets and nick-nacks, personal ornaments, and household utensils, glittering in all the untarnished radiance of the white metal. Nor to silversmiths proper is this display confined, but silver trifles, either for use or ornament, find a place in the windows of half-a-dozen other tradesmen and artificers. If this be the case in London, still more so is it in New York, where it would be difficult to find any article of daily use which one cannot procure, either entirely fashioned of silver, or in the adornment of which silver plays a most prominent part.

It is in articles of personal, and chiefly feminine, adornment that the new era of silverwork is chiefly noticeable in both countries, but especially so in America. Long swinging chatelaines, to hook on to the belt, and go clattering along by the wearer's side, suspending silver-covered note-book, silver-mounted scissors, penknife, pincushion, and so forth, by silver chains; silver-mounted shoe button-hooks, with chased and *repoussé* work handles; writing-cases, covered with plates of pierced silverwork; boxes of silver, for storing hair-pins; round boxes, for the storage of the delusive face powder and its feathery puff; quaint little receptacles for bon-bons; silver-handled brushes, silver-backed combs of tortoise-shell, and mirrors backed with hammered silverwork; heavy silver filigree buckles and girdles; silver-handled paper cutters, penholders, opera-glass holders, spectacle cases, postage stamp holders, pencil

cases, are displayed to catch a lady's fancy. For her husband and brothers the range is hardly less limited, and includes match-boxes of silver, cigarette and cigar cases, silver chests for cigarettes lined with cedar wood, hunting flasks, sovereign purses, shaped like tiny watches, key-rings, shaving-soap cases, and so forth; while, for domestic uses, or for the purpose of entertainment, gilt-lined bon-bon trays, tiny little lamps, inkstands, cigar ash-trays, photograph frames of filigree mounted on velvet, silver gong stands and bells, card-trays, grape-holders, candlesticks and snuffers, and the usual array of teapots, cream-jugs, and other articles, classed under the generic title of "household plate," are to be found everywhere.

When, however, we come to consider more closely, and compare the actual manner in which this fashioning is effected in the two countries, we are struck at once by the wide difference of method, almost of principle, employed. Roughly speaking, we may say that the silverwork of England is a tradition, and that of America a discovery. The silver-smith on this side of the water is hampered, I freely admit, in some directions. The mere fact of the standard fineness of his metal being rigorously guarded by law, while it has allowed the uninformed public to form a more sure estimate of the intrinsic value of his wares, has, in some mysterious way, lessened their artistic importance. For the last 200 years, at least, some sort of check seems to have been placed in this country on the manufacture of silver, though it was not until the beginning of the 14th century, I believe, that any actual legislation upon the subject was put into operation. It was then decreed that a leopard's head should be stamped upon all sterling articles of gold and silver. In the year 1337, the Goldsmiths' Company of London was incorporated by Edward III., and this body, until the present day, have been wont to imprint their company mark, which is the same leopard's head to which I have referred, upon all articles of sterling silver which are manufactured in London. As you are doubtless all aware, there are six other Assay Offices in this country, namely, those of Birmingham, Chester, Sheffield, Edinburgh, Glasgow, and Dublin. The Hall-mark, which, by these offices, is stamped upon the articles of gold and silver, is evidence that these have been tested and the latter found conformable to the invariable standard of 92·5 per cent. of silver, and 7·5 per cent. of alloy, or 11 ozs. and 2 dwts. of fine silver to 18 dwts. of alloy. Although there is now no duty on gold or silver plate, the Hall-marking is practically compulsory, and not only this, but foreign plate, although it comes in free of duty, must be marked before being placed on sale, and, in addition to the ordinary Hall-marks, have the letter "F" enclosed in an oval escutcheon. There is no manner of doubt but that this legal hampering of a trade or art which ought fairly to be as free as any other has seriously checked its development, at all events as regards what might have become many important branches of the main stem. At present, it is enough for me to point out that in America no such system prevails, and that to this fact is in some measure due the greater artistic freedom and originality which I hope to convince you is the distinguishing feature of the American silverworker. This craftsman, too, has been fortunate in being, to a much greater extent, free from the enveloping atmosphere of trade tradition, which has wellnigh asphyxiated his English brother.

When the modern English silversmith is a staunch copyist and artistic forger, his skill, in a mechanical direction, enables him to produce work which is pleasing to the trained eye, and his reproductions of Queen Anne work and Italian and Dutch Renaissance—as in the fashionable tea-services, on the one hand, and in, for instance, the elaborate open-work chatelaines, on the other—are, so far as copies can be so, satisfactory.

In the early years of the American colonies their silverwork, like the majority, if not the entirety of their luxuries, came to them direct, and by importation from the parent country. The old silverwork of Queen Anne and the early Georgian period is hunted for by the American collector, in his own New England and Southern States, with all the keenness that is displayed in the same search by those misguided people on this side the Atlantic who are accustomed to pay more for the Hall-mark than for the article itself. In the early days of the independence of the States I believe that little silver plate of any importance was manufactured in the country itself, and when, in the early years of this century, the trade had become more or less established in New York, Philadelphia, and Boston, it was to England, or perhaps more especially to France, that the craftsmen looked for their designs, which, I need hardly say, when the period is taken into consideration, were about as bad

as bad could be. The impetus given to all domestic and, notably, all artistic manufacture, in the United States by that extraordinarily epoch-making exhibition at Philadelphia in the centennial year of 1876, affected no less, indeed perhaps a little more than the others, the art of silver ware manufacture.

The most strenuous note in the American artistic character is a reflex of that which dominates their political faith. It is that of freedom, or, as in connection with art matters, the word might be spelled, originality. This, though at times it is apt in art as in politics to degenerate into license, is in the former happily restrained by that other, and perhaps more hopeful, American characteristic, appreciativeness. As in their architecture so in their subsidiary arts, the Americans seem unconsciously to assimilate, in a degree unknown to nations fettered by the bonds of tradition, all that is good in the art work of other peoples, and at the same time to impart to the conglomeration thus obtained a distinct flavour of their own individuality. In no branch is this more distinctly obvious than in their silverwork, though not a little of this virtue, for so I must consider it, is due to the life-labour of one man, whom I can only class, in the important influence he has exerted upon the American art of his generation, with that distinguished architect, Mr. H. H. Richardson, whose name, if not his work, is probably familiar to many here present. The man I refer to was curiously enough no silversmith himself; indeed, in the strictly technical sense of the word, he was not even an artist. I speak of the late Mr. Edward C. Moore, who was secretary to the Tiffany Company, to the kindness of whose London representative I am indebted for the loan of the few articles which you see before you to-night. Mr. Moore, at a time when his firm had already attained that unique position in the economic and social life of New York which they now occupy, recognised that they were in the habit, as is still the case with even the more important silversmiths of this country, of confining their designs for domestic table ware, to the few patterns which in the course of time have come to be considered as standard. Spoons and forks, for instance, were invariably modelled on the lines of the old fiddle pattern, the king pattern or the beaded, and, as is invariably the case when monotonous repetition prevails in a craft, that which originally may once have possessed some meaning and some beauty of its own had become a mere lifeless, senseless copy, with the vices of the original intensified, and its virtues rendered of no avail.

Almost from the first Mr. Moore succeeded in imparting to the work of his firm a virtue which I venture to think has been its leading characteristic ever since. And here, again, I must point out that in this he was but reflecting the spirit of his age and country. We may say what we will about American art work; we may abuse it (and in many cases we are perfectly justified in doing so) as being vulgar and *outré*, we may accuse it (and with justice) of an uneasy restlessness, which detracts to a large extent from its undoubted originality and cleverness; but in ninety-nine out of a hundred cases we find that it possesses the redeeming quality of interest. In no other branch of American art, and in no other American craft, is this quality more patent than in the silverwork. This I take it is the chief lesson which our silversmiths on this side of the Atlantic have to learn from America. Let me take as an illustration the most common and ordinary articles of household use. The peculiar qualities of silver, its malleability, its ductility, its practical freedom from oxidisation, and its indifference to the action of certain acids, render it not so much a luxury as a necessity for certain of our household utensils. Even the most economically-minded householder must, therefore, reckon among his belongings a certain number of silver spoons and forks. The intrinsic value of the metal would lead one to suppose that a certain amount of additional cost, in respect to the manual labour of fashioning it, might well be bestowed upon it. The articles which are made from it, and of which I now speak, will last more than one lifetime, and are constantly and recurrently put before our eyes, morning, noon, and night. It would certainly seem, therefore, that we are not asking too much if we demand from those who are responsible for its production, a certain amount of individuality and freshness of design as well as technical skill and soundness of workmanship. But in England there exist, among trade silverworkers, as I have already hinted, a more than slavish adherence to tradition and a slothfulness of mind, as it were, which no other craft can parallel. The spoons with which I eat my soup in my house I find reproduced in all their clumsy, heavy artlessness at the house of the neighbour I visit to-morrow, and were I to dine out in this England of ours on 300 of the 365 evenings of the year, I doubt whether in

the whole of that time I should handle more than three distinct patterns of silver plate. In America the case is far different, in that one finds in a majority of households a display of table ware which has been constructed to an original and a unique design. Not that each one has his table ware made specially to order, but the varied assortment of trade patterns of silver ware which are found not only at Messrs. Tiffany's, but at half-a-dozen other silversmiths' establishments in New York, Philadelphia, and Boston, renders it easy for the householder to choose some such variation from the standard and accepted shapes as will reflect more or less his own idiosyncrasy. Thus one finds that a New York dinner-table has something to attract one's attention and call forth either admiration or the reverse, while it gives also some clue, howsoever slight, as to the presence or absence of artistic taste and knowledge on the part of one's host. I want to say, and I must make a little brief excursion from my main subject to say it, that I expected to be able to show you to-night a representative collection of ordinary domestic American silverware. I had relied upon the kindness of the London representative of Messrs. Tiffany, but I had, in a measure, reckoned without my host, for I had forgotten the disabilities imposed upon a foreign workman by the legal trammels restricting the sale of silver in this country. Messrs. Tiffany are unable to keep on hand any of their more worthy examples, and what they have been kind enough to send to-night consist merely of a few odd pieces, which are but random and far from representative examples of their workshops. To these a friend has kindly added one or two pieces of ordinary domestic ware and ornaments. I should like you, however, at the close of my random little talk, to examine for yourself this simple spoon and fork, which is, apparently, as I hold it up, a mere variation upon one of our English stock shell patterns. Closer examination, however, will convince you that there is a distinction as well as a difference, and that the distinction is on the side of the American. It has what our similar pattern entirely lacks —proportion, subtlety, and grace of line, and, plain as it is, the perfection of modelling. From the practical point of view, too, it holds its own against its European competitor; it is well balanced and "holds itself," if I may so express it, in the hand in a manner which could only be the result of thought and intelligent care on the part of its modeller. Take, again, this little oyster fork, which requires a somewhat closer examination to reveal its good qualities. It is more ornate, but it is not on that account that I value it. I saw not long ago, in the shop of a West-end London silversmith, a collection of table ware which was much more elaborate and much more expensive than this little piece, but the engraving and the modelling of those English examples were, as compared with this, heavy, clumsy, and almost vulgar. They entirely missed the virtue which this, and which, indeed, the majority of American work, possesses, of being essentially silver and nothing but silver. I mean by this, that there is in every metal an inherent meaning and capacity which, beyond everything, should control the designer. The design which is perfectly proper and fitting for silver should strike us as manifestly out of place and inharmonious if applied to any other metal possessed of widely differing qualities. This to many of you present to-night will sound as the veriest truism—and so it is. Yet it is a truism which seems to be a heresy in the eyes of some English silversmiths.

As an Englishman, I cannot help experiencing a sort of vicarious shame when I go into shop after shop, house after house, and see the same painfully glittering and meaningless surfaces, the same commonplace curves, the same lifeless ornamentation, and compare them all, in my own mind, with the constant delight and pleasure I experienced in New York as I turned over the contents of an ordinary shop show-case, or called upon some friend whose acquisitive faculty had led him in the direction of silver ware. Here in England we are content, not so much to endeavour to revivify a corpse, as to hospitably entreat, and to be perfectly satisfied with the presence at our feasts of the mere mummy of an art. To travel out of the path beaten by the hammers, or the rut cut by the gravers of two centuries ago, seems to the English smith not only useless, but positively vicious. His fashions may change, perhaps, but they change only as regards the model he is content to slavishly follow. When he is a copyist he is too often soulless; when he summons courage enough to be original he is generally mindless. In America, on the contrary, he is ever on the look out, not only among the archæological dustheaps of the centuries, but in the world of science of to-day, and in the almost newly-discovered world of still living Oriental art. From science he has borrowed many a secret of metallurgy. From the East, and

from Japan especially, he has learnt many a lesson of form and colour. He has pressed into his service, sometimes, I own, with unwarrantable rapacity, the methods of other arts. He has not been content to simply engrave the surface of his metal, but has yearned for and obtained the freedom and facility of the etcher's needle. As regards this liberal and broad-minded subjection to outside influences, there is much that is worth consideration in the different attitudes which the English and American silversmiths have respectively assumed towards the marvellously beautiful and ingeniously scientific alloys which, under the names of shibu-chi and shakudo, the Japanese have known and cunningly worked for centuries; or towards the equally beautiful effects gained by the same artificers through the use of patinas, which give to silver and its alloys a bloom as of a sun-kissed peach or ripened plum. The English have passed them by with timorous indifference: the Americans have spent large sums of money and an infinity of thought and care, and while deftly refraining from any servile copying, have adapted rather than translated these foreign arts into their own language. You will see two or three examples of the curiously welded alloys to which I refer among the little collection here, and I would beg you to especially note that while the Japanese influence is undoubtedly strong, none of the pieces I have here could by any possibility be mistaken for examples of native Japanese workmanship.

It is, in fact, the strong desire of the American workman to avoid any appearance of actual copying, while I am afraid his English brother, supposing him to have the necessary skill to work in so ingenious a fashion, would use his utmost endeavour to turn out something which, in its imitative fidelity to the original, should deceive an expert Japanist. Even when he does not care to expend the time and labour necessary to produce these beautiful but necessarily expensive articles, the American silversmith has an eye for colour, and for the effects of contrast, which is apparent in some other of my examples.

His employment of copper, not in any secondary position, nor necessarily as a base metal, but as having a beauty of colour entirely its own—a beauty which may well be enhanced by the apposite radiance of the white metal—is as frequent as it is happy. The coffee-pot of Gorham manufacture, for instance, which you see here, is not by any means a perfect example of design, but it has, I consider, an amount of interest which would be altogether absent were it constructed entirely of the one metal. That the surface patina, produced by the slight oxidisation of time, is an important factor in our admiration of unique metalwork, has also been fully recognised by the transatlantic craftsmen; and, though I must confess he has carried this trick to an extreme in some cases, he has in others employed it with rare skill and good judgment. This fault of excess may be laid to his charge, also, in regard to the etching—of which I have before made mention—but that he was able to appreciate the value of a free, as compared with a mechanically-restrained incised line is certainly a point in his favour. In regard to this, I cannot resist telling a little anecdote which I only heard last night. An American friend of mine had a very dainty cigarette case, etched with a freely-treated design of thistles, decoratively treated. The lines were coloured, in a niello-like fashion, with a very soft and beautiful brown, a colour which gave value to, and agreeably contrasted with, the grey of the not too highly polished silver surface. She wished to have made here in London a writing case to match her thistle-adorned cigarette case, and to this end consulted one of the most eminent firms of silversmiths in London. They had never heard of etching upon silver, and did not believe it could be done, but they had no doubt they could engrave it to her utmost satisfaction. She debated with them upon this question of etching *versus* engraving, but to no purpose, and finally sent them the cigarette case as a model, and trusted, somewhat feebly, for the best. Her writing-case arrived home, with stiffly engraved commonplace thistles dotted here and there over its hopelessly burnished and brilliant surface, and with it arrived what once was her beautiful cigarette case, beautiful, alas, no longer! It looked like a piece of scratched and defaced tinware. When, breathless with indignation, she sought an explanation from the manager, she received the suave assurance, "You see, it looked so dirty, that we thought you would like us to clean it nicely, so as to match our own work. I can assure you," he added, "we had to use strong acid, in order to remove the ugly brown stains!"

But I do not wish to give the impression that the American silverworker is wholly given up to what some of us may consider his

fads and affectations. He can meet the Old World artist upon his own ground, and equal, if not excel him. I think the best work we have in this country is that in which *repoussé* work is largely employed. I have a little toilet set, which has been kindly lent to me by the friend whose cigarette case was so unkindly treated, which will show that the American *repoussé* work is not to be despised, though I by no means put it forward as a perfect example of its class. This little box, though chosen quite at haphazard, is evidence that while the mechanical skill displayed in their work is quite as great as that of our own hammerers, in freedom and individuality of design they are superior; while in the work with the graver, which may be said to add the cachet of distinction and personality to all good *repoussé*, they are, among modern workmen, unrivalled. Nor when they endeavour to work in a strict archæological style are they at fault. What I have said concerning their adaptation from the Japanese holds good also as regards their treatment of Renaissance forms. The bag-clasp which you see here is an instance of this, trivial and slight though it may be. It is quite in the manner of Italian 16th century work, as you will see, and yet with a distinctively modern note running through it. The little figures seem to me designed and modelled with a marked degree of graceful freedom, and yet of precision, while the cartouche of the buckle is in itself a lesson in little of the advantage of working in the spirit rather than according to the strict letter of a formal style.

I should also like to call attention to the pierced work, which, in its combination with glass, is so characteristically American. The flask you see here is an example of what I mean, and illustrates fairly well the manner in which they apply the methods of the old-time artists in metal to our 19th century requirements. Nor have the Americans forgotten that they are the inhabitants of a country richly endowed with forms of natural life which may be conventionalised and adapted to decorative purposes. The terrapin, the snail, and the bison have all been pressed into service with more or less success as decorative *motifs*.

I have been endeavouring, in sufficiently brief fashion, to impress upon you the fact that one at least of the arts of a country we are far too apt to consider as given over to the outward barbarian is worthy of our most respectful consideration. But let me insist that anything I may have said which appeared derogatory to our English work is meant to apply simply and solely to those articles of silver ware which any one can buy in any Regent-street or Bond-street shop, and, on the other hand, all that I have brought forward in favour of the American work, as compared with our own, is confined equally to the same class of articles.

I have seen in England specimens of artistic work in silver and other metals which will compare most favourably with the creations of the cinque-centtists and mediæval metal-workers, but almost invariably this work has proceeded from the studios of sculptors of eminence, or from the workshops of amateurs. I am not, of course, so foolish as to belittle the marvellous creations of such an artist as Mr. Gilbert, or even to undervalue the skill of Professor Herkomer, who, at his house in Bushey, has for some time been producing to his own design a service of carefully-modelled silver, which has much of originality to commend it.

In one respect, however, I may say a good word for our countrymen at the expense of the American. Ecclesiastical silver ware is to be found in some workshops here which cannot be paralleled either in America or in any other country in the world for its adherence to the best traditions of the mediæval craftsmen. It is more than archæologically correct, it is alive with the true spirit of the devotionally-minded silverworkers of an age when religion permeated the life of the artisan as well as of the priest. It is worth noting, by the way, that the same holds true as regards their architecture also. The American church work cannot be compared in any respect to the best of ours, though some of us are bold enough to consider that in domestic and commercial buildings they have a great deal to teach us.

Finally, let me endeavour to sum up the differences which I conceive exist between the silverwork of our own country and that of the world beyond the ocean. Here the workman is hidebound and fettered by tradition and trade custom, there he freely enlists into his service all that may in any way render his work more interesting or more individual. How much of this is due to the care that is taken in America to educate the workman in the art as well as the mere *technique* of his craft, I am unable to say. Certain it is that a firm such as that of Tiffany, to which I have so often referred this evening, has made it a point not only to choose its apprentices and

workmen from the more intelligent classes of the community, but have insisted on the necessity of their acquiring an education at the drawing-board as well as at the bench. To this end they have established special schools of art within their own little community, and their example has been widely followed by other leading firms. Nor should it be forgotten that of the purchasing public of the two countries each has its own peculiarities, and I think the American silverworker, who desires to cultivate art for art's sake, meets with greater encouragement financial, as well as otherwise, from his clients. At the same time this indifference to novelty and individuality is one that acts and reacts. Our silversmiths here declare that they are never asked for anything more than commonplace conventionality, but, on the other hand, they make not the slightest attempt to lead the public off the well-beaten path.

We are distinctly not an inartistic nation, and especially so as regards the applied arts, and the cordial encouragement which, in spite of all growls to the contrary from some of our leading decorators, I venture to assert, has been given to the creators of a new school of applied design in woven and printed fabrics, pottery and ironwork, leads one to inquire, with some degree of plaintiveness, whether it is not time for us to take a step forward, in what should be one of our most characteristic, as it has been, for centuries, one of the most carefully-cherished of our minor arts. May it not indeed be this very coddling and swathing up in bands of soulless tradition that has nearly stifled out its life, and if, even though it be at some loss to our self-esteem, we gain a breath of free air blown to us by the winds which set from off the shores of the New World, may we not look for a cordial acceptance of the new teaching by our art-loving English people?

DISCUSSION.

The CHAIRMAN expressed regret that Mr. Townsend had not had time to deal with some of the larger pieces of American silversmiths' work. One thing which struck him very much during a year's stay in New York was the appearance of the silversmiths' windows, not only the magnificent specimens to be seen in them, but the skill in which they were set out, so that one object did not kill another. It was proved there that the artistic was not necessarily the unsaleable. In cups or goblets for prizes, testimonials, &c , you did not see the same commonplace designs, nor in other articles for table use the imitation of unsuitable forms, which were too familiar in England, where a testimonial to one's merits too often took the form of an insult to one's taste. There were also traces of the influence of other national arts besides the Japanese. Persian work especially had had its influence, and also Indian and Saracenic ornament, and all sorts of Damascene ware might be seen. Niello and shakudo work also seemed to have a certain vogue. The marked character of American silver was that it seemed to have a certain style, which did not consist merely of originality, still less of novelty. It was with art, to some extent, as with literature. When a new genius appeared, he generally began by selecting his models very carefully, searching first amongst old materials and picking out those best fitted for his purpose, and then, by a happy audacity, introducing the colloquialisms of the day—those words born of their surroundings. When these were welded together, the result was either journalism of the worst type, or a new style, according to the genius of the writer, who could blend old and new, with his own individuality controlling all. One might say that adaptation was the mother of invention. It was just that welding together of old ideas and new in which the Americans appeared to have been so successful, and which made the great charm of their work.

Mr. LEWIS F. DAY had been much struck by the moderate way in which the reader of the paper had stated his case. Nothing had been said which the most susceptible English silversmith could well resent. There was not the slightest doubt that American work was much more interesting, and more individual than anything which had been done in England for some time past. He remembered seeing some of Tiffany's work at one of the Paris Exhibitions—not the last—and it was one of the two or three things which remained fixed on his mind. He was rather curious to know how the originality of the American work, which had been so much insisted on, was to be accounted for; whether the position of the artist, with regard to the employer, was in any way different in America from what it was in England, and how it was that he was allowed freer scope. In France, to some extent, the craftsmen were little masters, and a man could earn his living as an artist in silversmiths' work. In England, such workmen were brought up by large firms, and were practically compelled to go in the narrow trade groove, which made their work so uninteresting. How was it that in America, a commercial country, this individuality was possible? Was it that the American had more faith in art than the Englishman? America had not yet produced anything very great in the way of silversmiths' work, perhaps; but there was much more hope in it than in our work. That was what impressed him in American work—the hopefulness of it.

Mr. F. W. Fletcher expressed his pleasure at seeing the specimens of work in mixed metals or alloys of different colours, such as had been recommended by Professor Roberts-Austen. Professor Percy, he believed, was the first to introduce into Europe the idea of using these beautiful alloys, but English makers had been much too slow in taking up these combinations, by means of which the most wonderful effects could be produced. Silver, gold, copper, and platinum, might all be used with advantage. He had made a mixture of as many as seven metals, and he knew that Professor Roberts-Austen had tried very hard to get metalworkers to use the alloy called moku-me by the Japanese.* English silversmiths confined themselves too much to the one colour of silver. It was possible by alloying it with gold to produce a greenish yellow, and with copper to produce colours from light grey, termed shibu-ichi by the Japanese, to something like an orange. Copper, with a small proportion of gold would, by certain methods of pickling, produce a dark blue or purple; and another interesting alloy was gold and aluminium, which gave a beautiful ruby colour when the aluminium was added in small proportion, and did not require pickling to enhance its effect. There was a great field open for artistic workers in these alloys.

Mr. Hugh Stannus was much struck with the remark that English silverwork was tradition, whilst the American was discovery. It might also be said that in English design our artists appear to prefer the path of safety, like the great silver workers of Augsberg and the other imperial cities, in the Middle Ages, who had a tradition which they followed, whilst constantly seeking to improve; and that seemed to be the true path of progress; while the Americans were actuated by the audacity, the courage, the desire to seek new things, which characterised their Puritan forefathers, who left England two centuries ago to find a new world across the Atlantic. The same men who went out in the *Mayflower* would, if they lived now, make American silversmiths' work. The unfortunate effect of the English system of assaying and marking silver on design had been made evident in that room before. There was no doubt that it had a great influence in curbing in every way the individuality of English art. English people valued silver at so much per ounce, and wherever that was the case, it was adverse to any artistic work, because its convertibility was such a fatal factor. The purity which enhanced the value of an object in the eye of an Englishman also enhanced it in the eye of a burglar, and, in periods of depression, in the eye of the metal melter. Through the necessities of Charles I., much of the grand old mediæval plate of Oxford was lost to us, being melted down and coined into money. He (Mr. Stannus) had suggested to a friend that he should produce objects in which the material should be as nothing, and the art everything; that he should take pewter, which would never be melted down for its value as metal, and get his artists to put their best work into it. He might put silver or gold rims to his tankards, or a silver lining to the teapots, but the body of them should be pewter. Then he would satisfy all true artists, and there would be a chance of immortality for his work. Unfortunately, however, the British matron would not appreciate such work; she would have silver or nothing. He was entirely in sympathy with Mr. Townsend, with reference to the alloys and the patina which was formed upon the surface of some of the articles, and mentioned some old silver candlesticks, which had a beautiful patina, though there was always a strong desire on the part of the mistress to scrub it off. He thought he might be able to throw some light on the cause of this fine silverwork in America. He remembered how, some years ago, the head of one of the leading American firms went to Sheffield, and took back with him a small colony of the cream of the silverworkers in that town. Just as trees and flowers were the stronger for being transplanted, so it was in the case of these artistic workmen. Besides that, there was more purchasing power in America than there was in England, and, consequently, men were more encouraged to do their best. It would be interesting to know what was charged for the "fashion" of each of the pieces shown; so that a comparison might be made with similar English objects, which were sold at so much per ounce for the metal, and so much for fashion. If the prices were the same as in England, the superiority was certainly with America in some instances, but if they were not, of course there was no parallel. The toilette set, he ventured to say, he could not consider worthy of the encomiums passed upon it, and he thought any Sheffield chaser who turned out such work would get a wigging for it. The spoon, on the other hand, was an admirable piece of engineering, the rib running down the handle giving strength, and allowing the metal to be thinner at the edges; in English work the shank was the same thickness throughout, which was obviously a waste of metal. The same people who invented the sewing-machine and the type-writer had applied their brains to this kind of work, but he claimed the credit for Sheffield brains, sharpened, no doubt, by the American atmosphere. Americans attained originality, and doubtless, with a little more attention to art, they would attain a further stage, that of excellence. He remembered seeing Tiffany's work at the last Paris Exhibition but one, and it seemed to him to consist to a great extent in a glorification of hammer-marks. They knew that a bowl had to be hammered-out, but there was no necessity that the marks of the process should remain so apparent, because when the object came to be cleaned, the hammer-marks would partially disappear, and it would neither have the sharp marks of the hammer nor the beautiful

* See lectures by Prof. Chandler Roberts-Austen before the Society of Arts, 1888-90-93.

perfection of a spoon bowl. Tiffany's exhibit, at the last Paris Exhibition, appeared to be a mixture of Persian forms, with the freedom or irregularity of Japanese decoration in some cases; in others there seemed to be an attempt to cover the object all over with ornament. In any articles which required to be cleaned, the ornament was very much in the way. In all artistic matters it was well to see what other people had done; and he, therefore, desired to thank Mr. Townsend for having brought the subject before the Applied Art Section in so interesting a manner.

Mr. W. Aumonier said that he had been much interested in the paper, but should have liked to hear something more about the men who did the work, in particular, something about the Gorham Silversmiths' Company. He knew that the head man or art director there was an Englishman, and that there were several English designers. He should like to know whether this work was really done by Americans, or largely by imported labour.

Miss Webster said she paid a visit to America in 1888, remaining there all the year, and, though she missed some things there which were considered necessities in England, she was much struck with the superiority in many respects of their silverwork. The china in ordinary use, in Montreal, principally made at Trenton, in the United States, was very beautiful, and in Quebec she purchased for a trifling price some little articles in oxidised metals of various colours, which she had never seen anything approaching to in England. In New York she was much struck with the silver, china, and cut glass, which was superior to anything which could be seen in London. Every one who had spent only a few weeks in America must have noticed the longer hours of work, and the great energy and concentration with which the work was carried on. This was shown in the silverwork as well as in everything else. The spoon was a great improvement on the usual English pattern, but with regard to the oyster fork, though beautiful to look at, it was too elaborate in ornament for practical use, unless there were a butler and two footmen to look after the plate, as it would be very difficult to keep clean. For ordinary use table ware should have a smooth, plain surface. The engraved flask was very beautiful. On the whole, she thought the Americans excelled rather in ornamental articles than in those for daily use.

The Chairman, in proposing a vote of thanks to Mr. Townsend, said he hoped it would turn out that the workmen who had produced these articles were Americans; for, if they were English, it would reflect a double shame on England for not keeping them at home. What struck him, in connection with American table ware, was the severe simplicity of the design. In almost every case, they were without line or pattern of any description, but followed the most exquisite curves and shapes.

The vote of thanks having been carried unanimously,

Mr. Townsend, in reply, said he was quite conscious of the incompleteness of the paper, but he had not much time to prepare it, and had relied very much on having a good exhibit of the plain table ware referred to by the Chairman, as well as more elaborate nick-nacks. With regard to the cause of the originality to which he had referred, he thought it was due to the independence and individuality of the national character. The Americans were a nation of individualists, and it affected their art and architecture as much as it did their politics and ethics. They cared nothing for tradition in politics, and not very much for it in art. He thought that was, to some extent, a mistake, and that they would soon learn to appreciate what was good in former work. Here we had a great deal too much reverence for tradition, though we were now beginning to shake off those trammels. In many of the minor arts the Americans were a little ahead of us, simply on that account; but in matters of artistic sanity and taste they were behind, and, in fact, the more the two nations were brought in touch with each other on these matters, the better it would be for both. Again, women had greater influence in America than here. They were really the only leisured class at present, though one more approaching that of our own country was now growing up; now, however, the women did all the buying, and, to a large extent, led the public taste. This fact would help to explain many things. He had refrained from saying as much as he should have liked about mixed metals, because he had been preceded there by a much greater authority, Prof. Roberts-Austen, but to him it was one of the most interesting branches of American silverwork. He valued those few articles of mixed metals infinitely more than any of the other things. No doubt the habit of appraising value by the ounce affected English silversmiths' art very largely, and the craze for old silver was based very much on the same thing. Things were valued, not as examples of fine workmanship, but simply as examples of a certain date and as possessing a certain weight. He had seen this plainly exemplified at great sales. He should like to see pewter more used, but silver ware ought to be made so valuable that no price per ounce would pay for it. An American buyer never asked the weight of an article in silver. They were sold at so much the piece, and they were not very expensive; the oyster fork, for instance, was ticketed 13s. 6d. Of course, such articles would only be used on state occasions, and would not be injured by being a little oxidised or tarnished in the interstices of the ornament. This did not mean that it need remain dirty; it could be washed in hot water very easily. In reply to Mr. Aumonier he should say the workmen were all Americans; they were naturalised, at all events, in art. They might have been originally English; every

American was originally something else, but they had become thoroughly Americanised. A man went from here who had been accustomed to plod through his eight hours, or as much less as he could compass as his day's work, and there was not much go about him; but he had not been six months in America before he was keeping up with the procession over there. He believed climatic influences had a good deal to do with it, but the man became an American in a few years, and then he should be considered an American, although as a boy or a man, he might have been imported. Tiffany's was quite an American institution. He did not look upon it exactly as a shop; it was practically a co-operative society. Each man had an interest in the business, whether he sold the thing or made it. One spirit pervaded the entire establishment in a most extraordinary manner; as you went through the workshops you could see a different look in the man's eye to what you saw here, and he carried himself in a different way. That was the great secret; it began with the man who carried out the work. The man who drew the design had not so much to do with it; in fact, the greater part of it was work in which the design could only be a mere indication or suggestion of the finished result.

Mr. Edward J. Watherston writes:—Mr. Townsend's paper will, it is to be feared, be unpleasant reading to some of my brother silversmiths, but I confess to no slight degree of satisfaction, seeing that it repeats and, to a great extent, emphasises the evidence which I offered before the Select Committee on Hall-marking, in 1878. I have never altered my opinion. Nothing in the way of development of the art of the silversmith is to be expected, in this country, so long as compulsory Hall-marking, as at present practised, is the law of the land. Art students are not attracted to the trade; on the contrary, they are repelled. "Better to work in brass," say they; and they turn to brass and meet with success. Of course, in saying this, no reflection is cast upon the officers of our Assay Offices. They are not to blame. There are the musty old Acts of Parliament; there is the law; plate must be scraped and assayed in the manner adopted by our forefathers; and until the law has been reformed nothing can be done. But there is something to be said on behalf of the British silversmith, and I gladly say it. The art of the silversmith is hampered, not only by the hindrance of compulsory Hall-marking, but also by the craze for cheapness which pervades modern society. We are martyrs to the "per ounce" system. We do not escape even in the case of presentations to Royalty. Presents to the Duke of York will be, are, subject to the same test, weight of silver! Again, let s return to America. I fully agree with all Mr. Townsend says about the thoughtfulness of American silversmiths, and the time and care which they devote to their productions; but, remember, they are very well paid for the trouble they take. A forty-five per cent. *ad valorem* duty prohibits foreign competition, and, therefore, prices are enormous, and there is an ample margin of profit. That Messrs. Tiffany and Company make very fine plate must be admitted, but, as proved in the Paris Exhibition of 1878, prices ruled quite 50 per cent. above what is possible to be obtained for modern plate in England. Take spoons and forks as an example. English people want them, now, at 4s. 9d. per oz. How can art be expected to flourish at such a price? Certainly it could not in America. Lastly, we are martyrs to the old plate craze — old Hall-marks. There are people who will give any price for antique plate, however ugly, and however badly made. Even Vechte's Titan Vase, made for the Exhibition of 1851—one of the finest productions of this century—only found a home at Goldsmiths' Hall in the course of last year. Had it but been 150 years old, it would have realised a sum equal to twice its weight in gold. It would not stand the "per ounce" test; so, for more than 40 years, it failed to find a customer. And yet British silversmiths are blamed for not putting more art into their work!

Miscellaneous.

PRODUCTION OF OLIVE OIL IN SICILY.

Olive oil is made in Southern Sicily with hand machinery of ancient origin. The average season for grinding and pressing olives is from the last days of September to the end of November, although a large yield prolongs it into January. The United States Consul at Catania says that the olive trees grow equally well in the valleys and on the mountain sides, but olives of the lowlands are considered richer, and the oil made from them keeps its excellence for three years, while oil of the drier olives on the heights is not good after three years. The grinding and pressing are done in one room of a building, which, like all the farm buildings, is but one storey high, and usually has the earth for a floor. The olives are ground on a circular platform of solid masonry, about one mètre high and two mètres wide. The surface inclines towards the centre, in which stands a stout upright piece of wood. Parallel to this, and at right angles with the platform, is affixed a millstone some thirty centimètres broad and weighing about 800 kilogrammes. Into this wheel is fastened a heavy pole, to which a donkey or mule is fastened. The stone revolves very slowly, and a man with a spade is engaged in constantly turning the pulp. About 100 kilogrammes are crushed in half an hour, and the mass is then carried to the press in soft rush baskets. About fifteen of these baskets are filled and piled symmetrically in the press, with the openings of the

baskets in each case uppermost. Several pieces of wood are placed on the top of the pile, and a beam, which is held in place by four heavy poles, two at each end, is let down on the whole. A large wooden screw, above the middle of the beam, is turned by a lever worked by six or eight men, and a great pressure is thus brought to bear upon the crushed olives. The oil runs freely and passes through a trough into a hogshead underneath, this hogshead being nearly filled with water, through which the impurities tend to fall to the bottom. The pulp is left under pressure about five minutes, when a couple of quarts of boiling water, thrown on the pulp, washes the exposed sides of the baskets. The screw is then unturned, and the olives are taken to the mill, to be ground a second time for half an hour, while another mass is in the press. This process is gone through three times, when the thrice-ground and thrice-preserved pulp is taken into a dark room, banked up, and left there for three days, by which time it has attained a high temperature. It is then put into the mill again, and, after being ground, is pressed a fourth and last time. The remaining pulp—which, out of every 100 kilogrammes, averages 70 kilogrammes—is sold, and sent out of Sicily, to be worked again by more powerful machinery. Formerly, it was sold to the bakers for burning in their ovens, but the bakers now buy it after the fifth pressing. In the pressing, one half of the oil is obtained under the first pressure. The remaining quantity is extracted in nearly equal quantities from the other three. The fresh oil is quite green in colour, and is taken away as soon as the hogshead becomes filled. After a careful measuring, the oil is carried, usually in goatskins turned inside out, to another room, where it is poured into earthen jars, holding about 100 litres each. The jars, when new, are red and unglazed, both inside and out; and the same kind is made to-day as was used for the oil 20 years ago. The fresh oil is kept in a jar for eight days, although it clarifies at the end of four. A warm temperature is best adapted to the clarifying and preservation of the oil, but the changes of day and night do not affect the quality. At the end of eight days the impalpable foreign matter has sifted to the bottom, and the oil is ready for the table. It is then carefully poured into another jar, and awaits the pleasure of the manufacturer. After a jar is used, it is thoroughly washed with water and vinegar.

General Notes.

VIENNA ART EXHIBITION, 1894.—The International Exhibition of Art to be held in Vienna next year by the Genossenschaft der bildenden Künstler Wiens, with reference to which some particulars were given in the *Journal* of the 2nd inst., will last from March 1 to May 31.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 19...National Indian Association, Imperial Institute, South Kensington, 4½ p.m. Sir Raymond West, "Criminal Law and Procedure of the Ancient Hindus."

British Architects, 9, Conduit-street, W., 8 p.m. Presidential Address and Presentation of Royal Gold Medal to Mr. Hunt.

Victoria Institute, 1A, Adelphi-terrace, W.C., 8 p.m.

TUESDAY, JUNE 20...Society of Architects, St. James's-hall, Piccadilly, W., 8 p.m. Mr. H. A. Saunders, "Geometry in Design."

Statistical, School of Mines, Jermyn-street, S.W., 7¾ p.m. Dr. G. B. Longstaff, "Rural Population."

Zoological, 3, Hanover-square, W., 8½ p.m. 1. Messrs. Hamilton H. Druce and G. T. Bethune-Baker, "A Monograph of Butterflies of the Genus *Thysonotis*. 2. Miss E. M. Sharpe, "Descriptions of New Species of Butterflies from the Island of St. Thomas." 3. Mr. A. Smith Woodward, "The Osteology of the Mesozoic Ganoid Fish, *Lepidotus*.

WEDNESDAY, JUNE 21...Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Robert H. Scott, "Fifteen Years' Fog in the British Islands, 1876—1890." 2. Mr. W. L. Dallas, "Upper Currents of Air over the Arabian Sea." 3. Mr. E. D. Archibald, "Australian Climate and Weather."

Geological, Burlington-house, W., 8 p.m. 1. Prof. J. W. Judd, "Composite Dykes in Arran." 2. Mr. J. Postlethwaite. "Notes on an Intrusive Sheet of Diabase and Associated Rocks at Robin Hood, near Bassenthwaite." 3. Mr. R. Lydekker, "Two Dinosaurian Teeth from Aylesbury." 4. Capt. F. W. Hutton, "A new Plesiosaur from the Waipara River, New Zealand." 5. Mr. Robert F. Tomes, (i.) "Observations on the Affinities of the Genus *Astrocœnia*"; (ii.) "Description of a new Genus of *Madreporaria* from the Sutton Stone of South Wales." 6. Herbert R. Wood, "Study of the Dykes of Hope, Idaho." 7. Dr. Robert Sieger, "The Rise and Fall of Lake Tanganyika."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Dr. Nias, "The Development of the Continental Form of Microscope Foot." 2. Mr. C. Rousselet, "New and Little-known Rotifers."

Botanic, Inner Circle, Regent's-park, 2 p.m. Special Floral Fête.

United Service Institute, Whitehall, S.W., 3 p.m. Captain F. G. Stone, "Mobilisation for Home Defence."

THURSDAY, JUNE 22...East India Association, Westminster Town Hall, 2¾ p.m. Mr. Alexander Rogers, "Rayâtvari Settlements in Madras and Bombay."

FRIDAY, JUNE 23...United Service Institute, Whitehall, S.W., 3 p.m. Mr. J. J. Laughton, "Recent Naval Literature."

Physical, Science Schools, South Kensington, S.W., 5 p.m. 1. Mr. Nalder, "Exhibition of a Form of Carey-Foster Bridge." 2. Mr. Pidgeon, "An Influence Machine." 3. Mr. Wimshurst, "An Influence Machine." 4. Mr. Myers, "A New Volumeometer."

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition, is "Praxiteles, London."

Journal of the Society of Arts.

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FRIDAY, JUNE 23, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with sec. 40 of the Society's Bye-laws:—

TREASURERS' STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING MAY 31ST, 1893.

Dr.

	£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1892	979	14	3			
Do. in hands of Secretary	14	2	4			
				993	16	7
,, Subscriptions	5,700	9	0			
,, Life Subscriptions	504	0	0			
				6,204	9	0
,, Dividends and Interest				768	11	5
,, Ground Rents				322	19	6
,, Examination Fees				599	5	0
,, Prize Fund Donations:—						
Clothworkers' Company	20	0	0			
Mercers' Company	21	0	0			
Salters' Company	5	5	0			
				46	5	0
,, Advertisements				685	6	8
,, Sales, &c.:—						
Cantor Lectures	25	15	0			
Barry's Etchings	1	0	0			
Fees for use of meeting-room	40	19	0			
Journal	126	12	8			
Spoiled Postcards	3	6	9			
Jury Reports (1862)	2	2	0			
				199	15	5
				£9,820	8	7

Cr.

	£	s.	d.	£	s.	d.
By House:—						
Rent, Rates, and Taxes	380	8	8			
Insurance, Gas, Coal, House expenses, and charges incidental to meetings	428	0	10			
Repairs and Alterations	115	5	6			
				923	15	0
,, Office:—						
Salaries and Wages	2,179	9	0			
Stationery, Office Printing, and Lithography	284	17	5			
Advertising	84	0	10			
Postage Stamps, Messengers' Fares, and Parcels	194	13	5			
				2,743	0	
,, Library, Bookbinding, &c.				70	17	2
,, Conversazione (1892)				392	13	9
,, *Journal*, including Printing and Publishing				2,164	7	5
,, Advertisements (Agents and Printing)				372	9	1
,, Examinations				648	10	11
,, Medals:—						
Albert	21	5	6			
Society's	32	5	0			
				53	10	6
,, Drawing Society Prizes				11	2	0
,, Owen Jones Prizes				5	11	0
,, Mulready Prize				20	0	0
,, Cantor Lectures				193	6	7
,, Howard Lectures				100	0	0
,, Juvenile Lectures				20	0	0
,, Memorial Tablets				4	6	6
,, Sections:—						
Applied Art	61	4	0			
Foreign and Colonial	61	4	0			
Indian	74	16	10			
				197	4	10
,, Committees (General Expenses)				14	7	6
,, Investments:—						
Consols (Life Compositions)	504	0	0			
New South Wales 4 per Cent. Stock	516	6	0			
				1,020	6	0
				8,955	8	11
,, Cash in hands of Messrs. Coutts and Co., May 31st, 1893	833	6	7			
Do. in hands of Secretary	26	13	1			
				864	19	8
				£9,820	8	7

Liabilities.

	£	s.	d.	£	s.	d.
To Accounts due	362	0	10			
,, Examiners' Fees	271	5	0			
,, Examination Prizes and Medals.	60	0	0			
,, Do., Balance of Grants by City Companies	19	15	0			
,, Sections:—Applied Art, Foreign and Colonial, and Indian	190	0	0			
,, Accumulation under Trusts	470	19	0			
				1,373	19	10
Excess of Assets over Liabilities				18,651	8	4
				£20,025	8	2

Assets.

	£	s.	d.	£	s.	d.
By Society's Funds invested in—						
£11,165 6s. 11d. Consols, estimated at	11,000	0	0			
£500 Canada 4 per Cent. Stock, estimated at	525	0	0			
£500 South Australia 4 per Cent. Stock, estimated at	500	0	0			
£530 10s. 1d. New South Wales 3½ per cent. Stock, estimated at	500	0	0			
£500 New South Wales 4 per Cent. Stock, estimated at	515	0	0			
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock, estimated at	270	0	0			
£1,500 Queensland 4 per Cent. Bonds, estimated at	1,450	0	0			
£500 Natal 4 per Cent. Stock, estimated at	525	0	0			
Ground Rents	526	0	0			
				15,811	0	0
,, Subscriptions of the year uncollected	522	18	0			
,, Arrears, estimated as recoverable	185	0	0			
				707	18	0
,, Property of the Society, including Barry's Pictures and Lease of House				1,800	0	0
,, Advertisements on the Books, due, and in course of execution*				441	10	6
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1893				838	6	7
,, Do. on Deposit (interest on Trusts)				400	0	0
,, Do. in hands of Secretary				26	13	1
				£20,025	8	2

* A portion of this sum is subject to charges for printing.

Investments, &c., Standing in the Name of the Society.

	£	s.	d.
Ground Rents	£7,690	0	0
Consols	12,769	7	2
Metropolitan Railway 4 per Cent. Perpetual Preference Stock	500	0	0
Bombay and Baroda Railway 5 per Cent. Guaranteed Stock	2,450	0	0
Canada 4 per Cent. Stock	923	0	0
South Australia 4 per Cent. Stock	605	16	0
New South Wales 3½ per Cent. Stock	530	10	1
New South Wales 4 per Cent. Stock	500	0	0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Bonds	1,500	0	0
Natal 4 per Cent. Stock	500	0	0
Cash on Deposit with Messrs. Coutts and Co.	400	0	0

Trust Funds included in the Above.

		£	s.	d.	
1.	Dr. Swiney's Bequest	£4,500	0	0	Invested in Ground-rents, and chargeable with a sum of £200 once in five years.
2.	John Stock Trust	100	0	0	Consols, chargeable with the Award of a Medal.
3.	Benjamin Shaw Trust for Industrial Hygiene Prize	133	6	8	,, ,, ,, Interest as a Money Prize.
4.	North London Exhibition Trust	192	2	2	,, ,, ,, ,, ,,
5.	Fothergill Trust	388	1	4	,, chargeable with the Award of a Medal.
6.	J. Murray, in aid of a Building Fund	54	18	0	,,
7.	Subscription to an Endowment Fund	562	2	2	,,
8.	Dr. Aldred's Bequest	173	10	0	,, chargeable with the Award of a Prize.
9.	Thomas Howard's Bequest	500	0	0	Metropolitan Railway 4 per Cent. Perpetual Preference Stock, chargeable with the Award of a Prize for an Essay.
10.	Dr. Cantor's Bequest	4,600	0	0	Bombay and Baroda Railway Stock, and Ground-rents, Interest applied to the Cantor Lectures.
11.	Owen Jones Memorial Trust	423	0	0	Canada 4 per Cent. Stock, charged with the Award of Prizes to Art Students.
12.	Mulready Trust	105	16	0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13.	Alfred Davis's Bequest	1,053	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
14.	Accumulated Interest on Trust Funds	400	0	0	On Deposit with Messrs. Coutts and Co.

The Assets, represented by Stock at the Bank of England, and Securities, Cash on deposit, and Cash balance in hands of Messrs. Coutts and Co., as above set forth, have been duly verified.

Owen Roberts,
B. Francis Cobb, } *Treasurers.*

Henry Trueman Wood, *Secretary.*

J. O. Chadwick and Son, *Auditors.*

Society's House, Adelphi, 20th June, 1893.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Thirty-Ninth Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurers' statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday, the 28th June, at 4 p.m.

(By order of the Council),
HENRY TRUEMAN WOOD,
Secretary.

CONVERSAZIONE.

The Society's *conversazione* will take place at the Imperial Institute, South Kensington (by permission of the Council of the Institute) on Friday evening, June 30, from 9 to 12 p.m.

The reception will be held from 9 to 10 p.m. in the vestibule, by SIR RICHARD WEBSTER, Q.C., M.P., Chairman, and the Members of the Council of the Society.

Promenade concerts will be given by the Band of the Scots Guards in the West Gardens, and by the Band of the Royal Artillery, in the Indian Pavilion, from 9.15 p.m.

A selection of music will be performed in the vestibule by the Red Hungarian Band, commencing at 9 p.m.

The principal galleries will be open, including those containing the collections illustrating the natural resources of the Colonies and India, Indian art metalwork, &c.

The East and West Gardens will be specially illuminated.

Refreshments will be provided at the large buffet in the North Gallery, and at the Kiosk in the West Garden.

As part of the entertainment will be in the open air, visitors are advised to retain their hats, &c.

Admission will be by the main entrance in the Imperial Institute-road.

Those travelling by railway to or from the Imperial Institute will be allowed the free use of the District Company's subway, which leads from South Kensington Station to within a few yards of the Imperial Institute-road.

*** Members are reminded that Saturday, June 24, is the last day when tickets for their friends can be obtained by members at the price of five shillings each. After that date the charge will be seven shillings and sixpence. Applications received by the first post on Monday, June 26, will be treated as if made on the 24th.

Tickets can be procured by personal application at the Society's House, or by letter addressed to the Secretary. In all cases of application by letter a remittance must be enclosed. Each ticket will admit one person, and must be signed by the member to whom it is issued.

MEDALS.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1892-93:—

To JAMES DOUGLAS, for his paper on "The Copper Resources of the United States."

To WILLIAM KEY, for his paper on "The Purification of the Air Supply to Public Buildings and Dwellings."

To PROF. FRANK CLOWES, D.SC., for his paper on "The Detection and Estimation of small proportions of Inflammable Gas or Vapour in the Air."

To THOMAS R. DALLMEYER, for his paper on "Tele-photography."

To GISBERT KAPP, for his paper on "Some Economic Points in connection with Electric Supply."

To H. VAN DER WEYDE, for his paper on "The Pictorial Modification of Photographic Perspective by the use of the Photo-Corrector or Visual Lenses in Portraiture and Landscape."

To HERBERT THIRKELL WHITE, I.C.S., C.I.E., for his paper on "Upper Burma under British Rule."

To J. BARR ROBERTSON, for his paper on "The Currency Problem."

To SIR JULAND DANVERS, K.C.S.I., for his paper on "Indian Manufactures: their present State and Prospects."

To CECIL FANE, for his paper on "Newfoundland."

To H. A. MCPHERSON, for his paper on "The Philippine Islands."

To W. B. PERCEVAL, Agent-General for New Zealand, for his paper on "Aspects of Federation from a Colonist's Point of View."

To HUGH STANNUS, F.R.I.B.A., for his paper on "The Theory of 'Storiation' in Art."

To WILTON P. RIX, for his paper on "Pottery Glazes: their Classification and Decorative Value in Ceramic Design."

To PROF. W. M. FLINDERS PETRIE, for his paper on "Primitive Art in Egypt."

Thanks have been voted to the following members of the Council:—

To SIR EDWARD BRADDON, K.C.M.G., Agent-General for Tasmania, for his papers on "Australasia as a Field for Anglo-Indian Colonisation," and "Russia as a Field for Tourists."

To JAMES DREDGE, for his paper on "The Chicago Exhibition, 1893."

Proceedings of the Society.

CANTOR LECTURES.

MOSAIC: ITS HISTORY AND PRACTICE.

By C. Harrison Townsend, F.R.I.B.A.

*Lecture I.**—*Delivered May* 8, 1893.

We English seem in our design and the *technique* of our crafts to steer a middle course between the synthetical, but somewhat ponderous, knowledge of the methodical German student of art, and the gay empiricism of the French designer. We can point, and with pride, to our worthiest modern work—in stained glass, for instance, in wrought and cast-ironwork, in tapestry — and claim for each example a merit that is all wanting in what is put before us as the best work of the Continental, or even the American, craftsman.

It has not in all cases—it has in some—been left for us to determine the absolute principles that should be a law to the designer and worker. But it has been ours, more than any other nation's that I know of, to accept those conditions, and abiding loyally and frankly by the limitations with which we are brought face to face, to turn them (in the spirit of the true craftsman) from being possible hindrances and dangers into fresh opportunities and helpful elements.

To illustrate this, take, for instance, the art of stained and painted glass, and compare the best work one sees in Italy, Germany, or France with that of our own leaders in this field. The frank acceptance of the lead setting to the glass, and its conversion into a beauty and a gain, the sparing use of large vivid masses of positive colour, the glad approval of such inequalities in the glass as shall add a subtlety and depth of tone otherwise impossible — these, and many other elementary principles, were for Continental glasspainters to discover as for our own. But—and I deny partiality in making the statement—the recognition and carrying out of them seems peculiar to ourselves. I hold that it is to the best work of the best English designers that one has to turn to see the craftsman do that good and worthy work that is based upon a proper acceptance of the conditions imposed by the nature and limitations of his material.

I have mentioned stained-glass because I think that, in the hands of our best workers, it affords those who look carefully into it an illustration of work carried out on definite principles, both of *technique* and design. These are founded, as regards the former, on a close and careful study of what the work of the past has to show us in the way either of example or warning. The centuries before us have written their lesson large on the pages of the history of art; and there are some amongst our modern craftsmen who read and take it to heart, and try to profit by past successes no less than to avoid past failures and errors. And as to true design, their endeavour is, by a careful study of the material, its genius and properties, to apprehend the conditions its use imposes on us, and loyally accepting these, no longer as obstacles but as advantages, to welcome them as helpful servants rather than stern masters.

From this point of view it is that I hope to deal with my subject on the two evenings on which I shall have the honour of addressing you. In treating of "Mosaic: its History and Practice," I propose to consider first the history, methods, material, and *technique* of the art. Later on, we will together see what lessons remain for us, written in "the elder days of art" by our forefathers, confronted by the same difficulties as ours, and face to face with perhaps even sterner conditions than those of to-day.

Yet it is by no means as the mere dry-as-dust archæologist that I purpose asking you to join with me in a review of mosaic art in the past, but rather with the distinctly utilitarian view of profiting by a knowledge of what has been done before, to teach ourselves both what to do and (an equally important lesson) what to avoid, in our own practice of the art to-day.

Mosaic—to commence with a definition—is the production of an ornamental design by means of small cubes connected together and attached to a floor, wall, or ceiling by means of cement. These cubes, called *tesseræ*, may be of stone, marble, baked clay, or opaque glass.

My definition has the advantage of removing from our consideration certain pseudo-mosaic methods of work, which (partaking more of the nature of marble inlay than of a design com-

* This lecture was illustrated by 58 specially-prepared lantern slides. Recognition ought to be made of the facilities granted by the authorities of South Kensington Museum, who allowed the lecturer to avail himself of their admirable collection of drawings of mosaics, and to exhibit various panels and specimens of paper - squeezes of old examples. Thanks are also due to Mr. F. D. Bedford for the loan of sketches of Sicilian and other work.

posed of small *tesseræ*), do not, strictly speaking, come within the limits of our subject. Of these we are familiar with the Florentine mosaic objects sold in Florence at the present day, in which a spray of flowers, or a small figure subject is represented by shaped pieces of marble let into a matrix-piece or background of the same material, and generally black in colour. The flowers in the design are quite naturalistically treated, and the veining of the marble is called into play to obtain in a meretricious manner the colour effect of leaves and blossom.

One can say of this unworthy playing at art what Mr. Ruskin scornfully spoke of the grainer of imitation wood, that the "better" (so to call it) the workmanship, the more contemptible in a clever artist was it to do it at all.

Akin to this method, but on a much larger scale, and free from its false principles, is the work known as "opus sectile." In this also the design was formed by inserting shaped pieces of marble, serpentine or porphyry into a bed of the same material but of another colour.

Of this sectile work we have some beautiful examples in England. One, little known, occurs in Westminster Abbey in the pavement before the high altar, and in St. Edward's Chapel.

The "opus Alexandrinum" is a variety of the sectile, but of a narrower range as to the colours employed, which are generally black and white on a coloured ground.

The pavements at Ripon and Fountains, by the bye, often quoted as Alexandrinum or sectile, are in reality mosaics of glazed earthenware.

Some writers—for instance Professor Middleton—not only include the various methods I have mentioned within the word mosaic, but further extend its scope to comprise wood-inlay. But this, and indeed all the systems that imply the insertion of one material in a ground of another description, or those again that produce a decorative design by means of an incised ornament into which coloured paste—what the Italians call *impasto*—is introduced are, as I think, not mosaic in the true sense of the word. Of this *impasto* work I give by way of illustration the Death of Absalom from the nave floor of Siena Cathedral, and executed by Beccafumi in the first half of the 16th century. The tombstones in St. Croce, Florence, are good examples of this work.

Each of these various methods is interesting in its way, and worthy of separate study, but the field left me—even when I confine myself to my proposed limitation of the subject—is still so large that, as it is, I feel that the two evenings at our disposal only permit it to be traversed in part. This is particularly the case with the historical side of the art. How rapid my survey must be is evident when one recognises the fact that mosaic is, as it were, a microcosm of art, in which one may study the same influences that acted and reacted on art in general. In it we are brought face to face with the same modifications, due to causes sometimes far to seek, and the same growth, apogee, and fall.

To the pebblework arranged in patterns found in the temple of Zeus, Olympia, succeeded the further development of roughly squaring the stones. According to Pliny, it was in 85 B.C. that the art of mosaic work was introduced from Greece into Italy. Vitruvius gives us a careful and most useful description of the method of work, to which I shall again refer in my second lecture, when treating of the *technique* or practice.

Amongst the Romans, its use was spread as widely as their own dominions. From Northern Africa to Britain we find remains—"more lasting than eternal brass"—of the conquering nation's love of the art. In every country the discoverer's spade has found, under growing crop or busy modern street, true "pictures in stone" of a surprisingly wide range of invention, and of finished excellence of workmanship.

With the Romans, up to the time of Augustus, the designs were of the simplest, and, after that time, it is curious to notice that it was for long the custom to reserve more particularly the floor-surface for their figure subjects. Amongst their designs a very favourite device was to strew the ground with the *débris* of a feast—bones, nut-shells, &c. Examples of wall-panels exist, however, as at Pompeii in the beautiful fountain recesses, of one of which I show an example.

One of the very finest specimens of Roman—or, as I think, Greco-Roman—design and workmanship is the large panel found in Pompeii, now in the museum at Naples, and commonly called the Battle of Arbela, or Issus (fought between Alexander and Darius B.C. 331 or 333). My outline illustration of this spirited composition will show that its great merit justifies one in ascribing it to an artist of considerable power, and its pictorial effects of aerial perspective, and so on, lead one further to conclude that it is most probably a copy of a celebrated picture by a

Greek artist. I give a further detail of the head of one of the Persian soldiers. The work has an interestingly free use of marble and enamel glass *tesseræ*, as the artist thought best for his particular effect.

Lastly, before leaving the ancients, as an example of the small mosaics which the Romans were wont to move about from place to place—cabinet pictures in fact—the well-known "Doves of Pliny" are worth a moment's consideration. The mosaic itself, found originally in Hadrian's Villa, is now in the Capitoline Museum, Rome. It is a variant of a favourite Roman *motif*—pigeons drinking from a bowl and pluming themselves on its edge. It is interesting to note that he mentions that it is the work of a Greek, Sosus by name. How usual a subject this was we shall see when we recognise it later (in the tomb of Galla Placidia, at Ravenna), in a mosaic of the 5th century.

In no way was the shifting of the centre of the world's government from Rome westward to Byzantium more noticeable than in its effect on art, and on that form of it we are considering in particular. When in 330 Constantine removed thither his imperial throne, he determined to embellish his favourite city with the sumptuous luxury and grandeur fitting to his dream of a great capital of the world. Architects, sculptors, mosaic-workers, all were summoned to his court and held high place in his favour. The latter, indeed, were by his special imperial rescript exempted from certain forms of taxation! And the school founded by him acted upon, and in its turn was acted upon by, the traditions of the older city.

Earlier than the 4th century, it is difficult to point to authenticated examples for our study, and even of that century we have remaining to-day but few works. One of those, however, executed in Rome and elsewhere under the orders of Constantine is still to be seen in the church of St. Constanza, Rome. It presents a very curious point for discussion in the nature of the subjects adopted by the artist for the decoration of the barrel-vaulting of the aisle or ambulatory. The colour-scheme is white ground; brown vine-stem, thin and delicate; leaves ranging from pale green to full, almost black-green; grapes, Indian-red outline; birds, generally yellow-brown or else blue; genii, also blue; winepress cart, oxen, brownish grey; drapery of figures, generally yellow, bright red lines, and brown shadows. The photograph shows how extraordinary his choice has been, and were it not that this same subject of the Vintage has been discovered on Christian sarcophagi, one would not hesitate to pronounce the wine-treading, the little genii in the vine-stem, and in fact the whole subject as distinctly and decidedly Pagan. Other bays of this ceiling have geometrical and other patterns. The colour here is a blue pattern (with red shading) on a white ground. The figures are generally blue.

In the Chigi Library, Rome, is a head of Flavius Julianus, found in the catacombs, which is noteworthy as giving us what is perhaps the first instance of the use in Christian mosaic of the gold-faced *tesseræ*. Of course there is always, however, the possibility that these may be the outcome of the restorer's work.

A very beautiful composition of the 4th century is the apse-mosaic in the Church of Sta. Pudenziana, Rome. (Fig. 1, p. 751.) On a pale blue ground, on which greyish clouds float, occur the four evangelistic emblems, executed in soft blue-greys; and in the centre of the upper portion of the vault a gold cross decorated with gems is raised on a bare and simple mound. The Saints—eleven in number—are ranged in front of a portico treated in white, and with a roof of pale olive-green tiles. The figure of Christ, who holds an open book in one hand, is clothed in gold-coloured drapery, with the high lights worked in gold-faced *tesseræ*, and He is seated on a richly-worked throne. The tones throughout are low and cool, even the touches of stronger colour being the reverse of vivid. The figure on the left hand of our Lord, for instance, has pale yellowish-green drapery, with the folds worked in a shade of blue-green. In my own judgment, we shall have to travel far along the ages, in our consideration of early mosaic workers, before we face the next design that breathes so pure and delightful a spirit as this charming inspiration.

The 5th century is one that—embracing, as it does, some of the Ravenna work—offers us much to study. The treatment, as we shall see, still retains strong evidence (as in the draperies) of classical principles and their influence on the designers. Amongst the four or five works of this period in Rome, perhaps the most important were the triumphal arches of St. Paul extra Muros, and of Sta. Maria Maggiore. The former I would dismiss with the statement that the present mosaic is what is vaguely called a "reconstruction" of the old one (after the latter's destruction by fire

n 1823), but for the fact that I can show a photograph of the only portion known to have escaped that disaster. It is the head of an angel, and it serves to illustrate the strong Roman feeling I have mentioned. Of the work in Sta. Maria Maggiore I give an illustration. The subjects are the Annunciation, Presentation, Three Magi, Christ disputing in the Temple, and the Massacre of the Innocents, with Jerusalem and Bethlehem represented in the lower portion of the spandrels. It is a curious point, by the way, to notice that, with a generous impartiality, the mosaist has given haloes, not only to the Archangels, but even to Herod! In the two top rows of subjects, the background is gold as high as the level of the heads of the figures, and above that cobalt blue. The ground on which they stand is throughout green. The figures have white or blue haloes, and their drapery is light in tone, with folds of a stronger tint of the same colour. The arch enrichment is in alternate blocks of blue and red. Bethlehem is here worked in greys, while the other city is indeed "Jerusalem the Golden."

It was in 402 that Honorius, for strategical reasons, removed his court to Ravenna, with every hope of making it the most important port on the Adriatic. But neither King Canute nor Honorius succeeded in compelling the sea to their will; and to-day the great seaport—the Venice of the Romans—is an unhealthy, desolated town, left dry by a sea which has receded six miles from the harbour where once rode the navies of Imperial Rome.

FIG. 1.

STA. PUDENZIANA, ROME.

However, some 20 years after Ravenna became the seat of the empire, the Empress Galla Placidia, widow of the second Constantine, took up her abode there; and it is to this enlightened patron of the arts that we owe the mosaics in the baptistery of the orthodox, or St. Giovanni in Fonte, those in the chapel attached to the archiepiscopal palace, and in SS. Nazario e Celso, or, as it is more commonly called, the mausoleum of Galla Placidia. The archbishop's palace has been much restored, but certainly shows us the old design. I give a photograph of the figure of the Virgin. As regards the tomb of Galla Placidia, the building itself is small in size, and is in plan a Latin cross, with a ceiling entirely covered with mosaics. It contains not only the founder's tomb or sarcophagus, but those of her husband, and of her brother Honorius. The mosaic over the door represents Christ as a shepherd, young, and beardless, which may be compared with the mosaic opposite to it, where, as a bearded man, he is committing an heretical book to the flames. In another, the occurrence of what is evidently a reminiscence of the piece known as "Pliny's Doves," which I have already mentioned and illustrated, should be noted in the slide I now

show. The backgrounds are generally blue, the draperies white.

The dome of the octagonal baptistery of the orthodox, adjoining the cathedral, has an important composition of the Baptism of Christ forming the centre of the vault, with the Twelve Apostles below, all again executed on a blue ground. Below is a broad frieze, on which are represented the four gospels on altars and four crosses. Their robes are alternately white and gold, and yellow and gold. The Christ and the St. John have pale greeny-blue haloes with red outline. The two important points in connection with this work are, firstly, to note that it is all but certain that the central and principal portion is, fortunately, untouched and unrestored, and, secondly, to remark once more the distinctly Roman character of the design. Thus the river Jordan is quaintly enough represented by a river-god pouring, in true classical and pagan manner, the stream from an urn. The lower portions of the eight walls are treated with scrolls in green and gold on a very dark blue (almost black) ground. But this work has lately been dreadfully restored. Sta. Maria in Cosmedin, or the baptistery of the Arians, is, as the slide shows, but a poor copy or rival of what we have just seen, identical in idea, even to the introduction of a human personification of the Jordan.

The 6th century, on which we are now entering, was prolific in mosaic works, and more especially at Ravenna, where Theodoric the Great revived much of the splendour that was in danger of being dimmed by its conquest, in 476, by Odoacer.

Fig. 2.

St. Apollinare Nuovo, Ravenna.

St. Apollinare Nuovo, built by the Arian Theodoric, has a series of highly important mosaics. These, however, still show neither the handiwork of the Goth nor the Greek, but are as Roman as those that precede them. The walls of the nave are enriched on either side with a processional treatment, representing on the north the neighbouring town of Classis, whence issues a procession of twenty-two virgins bearing crowns, and advancing towards the Virgin Mary; while, on the south side, male saints, twenty-five in number, do similar homage to our Lord (Fig. 2), who is seated on a richly decorated throne, clad in the imperial purple. The colour scheme is very beautiful. The virgins' over-robes are gold, with red and green spots of ornaments; their dresses white with grey shading, and their shoes red.

The work was badly restored some twenty-five to thirty years ago. Our Lord originally held a sceptre; for some inscrutable reason this was changed to an open book. The colour of the new gold is as bad as we always find it in modern work.

Above these processions occur the Apostles placed between the clerestory windows, and over them again various scenes in the life of Christ. Here, curiously enough, our Lord is only represented with a beard in the latter events depicted. No crucifixion scene is

ıown; it was a subject so far abhorred. A ›rtrait of Justinian occurs in the last chapel ı the north, and was formerly outside the ›rtal.

The other St. Apollinare—that in Classe—ıe last and only remains of the old imperial ty of Classis, presents a no less character-tic and beautiful series. In the apse Christ surrounded by the Evangelistic emblems and ıe archangels SS. Michael and Gabriel.

The panel of Melchisedek feasting is a peciallyinteresting photograph, as the restora-on of the mosaics is very imminent, and it is ell to have seen it before that entirely de-tructive operation.

The very rare use of silver leaf *tesseræ* occurs in these mosaics. Mother-o'-pearl, ivory, and egg-shell also were used, I have heard, but I could not find traces of the latter when in Ravenna a month ago.

The octagonal church of St. Vitale was actually begun before St. Sofia, Constantinople, for which it served as a model, and of which I shall say something hereafter, but it was completed considerably later. The choir is enriched with a figure of Christ enthroned on the globe, angels on both sides, while on the right and left respectively are St. Vitalis, Patron Saint, and Archbishop Ecclesius the founder (Fig. 3). Below are, on the north, the Emperor Justinian and Maximian, and, on the south, Theodora, with her ladies. Of these, I give

Fig. 3.

St. Vitale, Ravenna.

llustrations, as also of the heads of the two ›rincipal figures, to a larger scale.

The Basilica of St. Lorenzo-fuori-le'-mura, Rome, contains a mosaic towards what was ›nce the eastern end of the church, till a re-›rientation caused it to face the apse. Its subject is Christ seated on a globe, with, on either side, St. Peter, St. Lawrence, St. Paul, St. Stephen, and Hippolytus, and Pope Pelagius, the founder.

The most important work in the Holy City during this 6th century was, however, the decoration of the Church of SS. Cosmo and Damian. The Lamb Enthroned is surrounded by seven candlesticks, and appearing from clouds are the two Evangelistic emblems of St. Matthew and St. John. The rest of this apocalyptic subject has disappeared. The figures at each side (in the apse) are Pope Felix and St. Theodore. The Pope has undergone many changes. Originally Felix IV., in the 16th century the then Pope repainted the face to represent Gregory the Great. Later, Alexander VII. restored it, but in the style of his own time, the latter half of the 17th century. The other two figures are St. Paul presenting St. Damian, the physician.

So connected in matters of art no less than politically were Constantinople or Byzantium and Ravenna, and so natural is it to associate any consideration of San Vitale with that of St. Sofia, that a few words as to the little we

know of the wonderful mosaics in the latter church are necessary here.

The building, commenced in 532 and finished eight years later, was destined by Justinian to eclipse all hitherto existing Christian churches. Now that he had shifted the centre of government westward from Rome to Byzantium his dream was to make the latter city the most imposing and gorgeous in the world. And thus he called to his aid for the beautifying of his new Basilica of St. Sofia the services of the best artists he could obtain, who lined its interior with magnificent marbles, and covered its upper walls and ceilings wit the most brilliant of mosaics. These—or man of them—to-day lie hid under the coats whitewash due to Mohammedan bigotry an ignorance. But in 1847 during the course some repairs to the structure ordered by th then Sultan, Herr Von Salzenburg had fortunate opportunity of making drawings some of them. These help us to see ho glorious a building must this have been, which its imperial builder is reported t have said "Solomon, I have surpassed eve thee!"

FIG. 4.

ST. PRAXED, ROME.

"The pavement glistening like sheets of silver; the many tinted marble pillars shining like a marble firmament; the walls sheeted with mosaic exected with all the art that the age afforded. A giant effigy of Christ, the Virgin and Saints over the High Altar, and four mighty archangels enfolded in purple wings, in the spandrels of the dome, looking down on the Sanctuary containing the sacred vessels and on the jewelled veil dividing it from the nave."

The colour treatment of the figures appears to be soft and simple in scheme. In the groined vault of the gallery effects are obtained by the use of masses of silvery-faced *tesseræ*. I only know of their use here, very sparely i St. Mark's Venice and in St. Apollinare i Classe, which I have just mentioned.

In the following century Honorius (625-640 built and decorated the Church of St. Agnes where, in the picture on the tribune, th mosaist has quaintly enough inscribed a glow ing criticism of his work in gold letters on blue ground.

The great work of the 8th century, th mosaics—not in Italy this time, but at Aix-la Chapelle—are lost to us by the successive fire in 1656 and 1730. A beautiful little work o

is date, however, still remains to us in ance, at Germigny des Prés.

The Council of Constantinople, by its forulation of a decree against direct reprentation of the figure, had a momentous fluence on Christian art. The direct effect this iconoclastic movement early in the h century was to drive the figure artists it of the Greek Empire, and the influnce of these methods and theories was enceforward felt over the whole of the oman world. The decree was abrogated 787, and the immediate effect was a igorous revival of art enterprise, especially mosaics.

Amongst the works executed in Rome, that t Sta. Francesca Romana (usually considered f this period), we will consider later when eating of the 12th century, to which it ndoubtedly belongs.

The church of St. Praxed, with its humble and insignificant exterior houses, however, is a very important series. But the treatment is noteworthy, not so much from the nobility of idea in its conception as from the crude and barbaric method of its execution. The vault of the apse is blue, and on it is represented Our Lord clothed in a gold mantle with red shading, and holding a volume in His left hand. On His right Pope Pascal appears, with a square nimbus—an indication that he was living at the time of the execution of the work. The figures in the Chapel of San. Zeno here are greatly superior to those of the church proper. I show (Fig. 4) a portion representing SS. Paul, Pudentiana, and Zeno. The mosaic in St. Ambrogio, Milan, is also of this date, and probably the western arches of St. Sofia, representing the Virgin, St. Peter, and St. Paul.

FIG. 5.

ST. MARK'S, VENICE.

But signs of decay had for long been manifesting themselves—in Rome especially—in the mosaic art, due not only to the increase of Byzantine influence, but to the luxury which led to the Popes and others putting in hand so many works at once, and the evident speed and carelessness with which they were carried out.

During the 10th century we have no mosaics of note to signalise. But in the 11th century a fact of very far-reaching importance took place. The head of the monastery at Monte Cassino, after his return from Constantinople (where he had become imbued with a love and admiration for the art of the West), despatched agents to Constantinople to bring thence "craftsmen cunning in the arts of mosaic and inlay." And at the same time workmen of Greek extraction or training were employed at St. Mark's, Venice. The lunette over the inner side of the west door—our Lord between the Virgin and St. Mark—is of this

date. In it, by-the-bye, we notice again one of the few uses of silver, here in the nimbus of the principal figure. And the central panel in the ceiling of the Baptistery—the baptism of our Lord—as well as the scenes from the life of St. John the Baptist are of this time. Of a series of the early Christian Fathers I give the representation of St. Athanasius.

The atrium or narthex (the place occupied by the unbaptised) was enriched with scenes from the Old Testament. They consist of events in the histories of Noah, Abraham, Joseph, and Moses. I give an illustration (Fig. 5) of one of the Noah series, as to which the following are my colour notes:—The ar is almost black; Noah is in white robes wit bluish shading; the doors of the ark are ha silver and half gold; water blue, with whi edges to the waves. There are two lines of gold *tesseræ*, as well as a black outline, roun the figures. The rainbow is emerald, chrom yellow, and Venetian red.

The pavements—one of the glories of S Mark's—were commenced in the 11th centur and have been very many times repaired an reconstructed. The illustration of them m slide gives you only hints at their intricac and ingenuity of design. The cruel restorer still at work on them, and each time one revisits Venice, he finds a fresh piece has gone —for ever.

Fig. 6.

Sta. Francesca Romana, Rome.

The mosaics of the 12th century were many and important. At Rome, St. Maria in Trastevere underwent decorative treatment, to be followed by another in the 14th century, which we shall duly consider later on. The composition of the Virgin enthroned, of this date, is curious, for on the right and the left of her are ten virgins holding lamps, of which only two are unlit. Is it, as has been imagined, a piece of thoughtless work in the execution of the Parable of the Ten Virgins, or are the figures those of persons in adoration? If the latter case, why the extinguished lamps?

Another very beautiful series is that in Sta. Francesca Romana (Fig. 6), recently proved to be of 12th, not of 9th, century date, the period to which it is usually assigned. The fou saints occupy niches with semi-circula bands; the Virgin and Holy Child form th central group. The velarium treatment of the upper portion of the apse is a very pleasing departure from the usual designs.

(To be continued.)

MEETINGS FOR THE ENSUING WEEK.

Tuesday, June 27...Statistical, School of Mines, Jermyn street, S.W., 5 p.m. Annual Meeting.
Photographic, 50, Great Russell-street, W.C., 8 p.m

Wednesday, June 28 ... SOCIETY OF ARTS, John-street Adelphi, W.C., 4 p.m. Annual General Meeting
British Astronomical Association, Barnard's-inn Holborn, 5 p.m.
Royal Society of Literature, 20, Hanover-square W., 8 p.m.

Thursday, June 29...Victoria Institution (at the House of the Society of Arts), 8 p.m.

Friday, June 30...SOCIETY OF ARTS. Conversazione. United Service Institute, Whitehall-yard, 3 p.m.

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FRIDAY, JUNE 30, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

NEW VICE-PRESIDENTS.

At a meeting held on Wednesday, June 28, after the Annual General Meeting, the Council elected (in accordance with the Bye-law passed at a General Meeting held on May 18, 1892) the following gentlemen as Vice-Presidents of the Society:—Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., R. Brudenell Carter, F.R.C.S., Lord Alfred Churchill, Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., and Sir Owen Roberts, M.A., D.C.L., F.S.A.

The terms of the Bye-law passed at the General Meeting held on May 18, 1892, are as follows:—"That in accordance with the proposal from the Council, the Bye-laws be altered and varied in such manner that the Council shall be empowered, during the years 1892 and 1893, to appoint not more than six members to be Vice-Presidents or other Members of the Council, in addition to those appointed under Bye-laws 79 and 84, and that the Council be empowered to determine the period or respective periods that members so appointed shall continue in office, not being later than the end of the Session commencing 1893, and that all Bye-laws which are inconsistent with such appointment and determination be suspended or varied."

CHAIRMANSHIP OF COUNCIL.

On Wednesday, June 28, at their meeting, held after the annual election, the Council elected Sir Richard Webster, Q.C., M.P., as Chairman, and Sir Frederick Bramwell, Bart., D.C.L., F.R.S., as Deputy-Chairman, for the ensuing year.

The various Committees were also re-appointed.

THE ROYAL MARRIAGE.

The offices of the Society will be closed on Thursday, July 6, in consequence of the marriage of H.R.H. the Duke of York.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Monday, June 26. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., Sir Edward Birkbeck, Bart., Sir Edward Braddon, K.C.M.G., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Michael Carteighe, Sir George Hayter Chubb, Francis Cobb, Professor James Dewar, M.A., LL.D., F.R.S., Major-General Sir John Donnelly, K.C.B., Sir Henry Doulton, Prof. Clement Le Neve Foster, D.Sc., F.R.S., Charles Malcolm Kennedy, C.B., John Biddulph Martin, John Fletcher Moulton, Q.C., F.R.S., John O'Connor, William Henry Preece, F.R.S., Professor William Chandler Roberts-Austen, C.B., F.R.S., Sir Owen Roberts, M.A., D.C.L., F.S.A., and Sir Saul Samuel, K.C.M.G.

Proceedings of the Society.

ANNUAL GENERAL MEETING.

The Annual General Meeting, for receiving the report from the Council, and the Treasurers' Statements of Receipts, Payments, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Bye-laws, on Wednesday last, the 28th June, at four p.m., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Deputy-Chairman of the Council, presiding.

The Assistant-Secretary read the notice convening the meeting, and the minutes.

The following candidates were proposed, balloted for, and duly elected members of the Society:—

Adams, George, 2, Adelaide-terrace, Ilfracombe.
Carlet, Remy Lovis, 81, Finsbury-park-road, N.

Carpmael, Alfred, B.A., 375, Norwood-road, Lower Norwood, S.E.
Hale, William Carlton, Ivy-hall, Wrotham, near Sevenoaks, Kent.
Hannen, Charles, Aylestone, near Leicester.
Hight, Arthur Edward, Kaira, Guzerat, Bombay Presidency.
Howell, Edward James, Kingston-house, Caterham-valley, Surrey.
Keen, John, 151, Johnson-street, Victoria, British Columbia.
Lineham, Professor Wilfrid James, Jesmond, Leyland-road, Lee, S.E.
Livens, Frederick Howard, Lincoln.
Lyall, Sir James Broadwood, G.C.I.E., K.C.S.I., 43, Bramham-gardens, S.W.
Millar, Alexander, Hollyhurst, Clapham-common, S.W.
Neild, Frederick, 37, Tavistock-square, W.C.
Proctor, William, 89, Corporation-street, Manchester.
Reuter, Baron George de, M.A., LL.B., 18, Kensington Palace-gardens, W.
Rhodes, Caleb, 4, Grosvenor-terrace, Beverley-road Hull.
Richardson, Oliver A., Sun Fire-office, Threadneedle-street, E.C.
Silver, Arthur, 84, Brook-green, W.
Slingo, William, 65, Chelsham-road, Clapham, S.W.
Sotheby, W. E., B.A., 124, Regent-street, W.
Vander, John, 59, South-side, Clapham-common, S.W.
Waller, Thomas William, 10, Westbourne-street, Hyde-park, W.
Yeatman, F. F., Electric Light Depôt, Reading, Berks.

The CHAIRMAN nominated Major John L'Aker and Mr. Julien Tripplin scrutineers, and declared the ballot open.

The ASSISTANT-SECRETARY then read the following

REPORT OF COUNCIL.

I.—ORDINARY MEETINGS.

In the past Session, a large number of valuable papers were, as usual, presented to the members at the Ordinary Meetings. The subjects were varied, and included some of the most important topics that have interested men's minds during the year. The address of the Chairman of the Council, delivered at the opening meeting, contained an account of the proceedings of the Society during the preceding Session, and specially noticed those subjects which had previously occupied the attention of the Society. Sir Richard Webster also described the condition of the Chicago Exhibition at that date, and illustrated his remarks by a series of lantern slides.

At the second Ordinary Meeting, Mr. Seymour Haden read a paper on "Cremation as an Incentive to Crime," in which he pointed out the dangers that he considered inseparably connected with the practice of cremation, and stated that the objections made to burial did not apply to an improved system which, he hoped, would be introduced in the future. The Chairman (Dr. Poore), in the discussion which followed the reading of the paper, urged very strongly the necessity for burial, and the danger of general cremation considered as a cause of the starving of the earth.

Mr. James Douglas read a valuable paper on November 30, on "The Copper Resources of the United States," in which he pointed out how large had been the increase in the production of copper of late years in the United States, which had been raised to the first position as a producer of this metal. Mr. Douglas further pointed out that, in the future, it was probable that America would work its own products to completion, and that much less copper ore or regulus would be sent to this country to be smelted than heretofore. This point was further considered in the discussion that followed the reading of the paper.

As devoted to a kindred subject mention may be made of a paper by Mr. Bennett Brough, on "The Mining Industries of South Africa as shown at the Kimberley Exhibition." Mr. Brough visited this Exhibition, and has given a very interesting account of that division which he was specially competent to criticise; together with a full description of the exhibits of diamonds, gold, and miscellaneous minerals. Members will remember that, before the opening of the Exhibition, Mr. Atkinson read a paper on its prospects.

Early in the Session Mr. Dredge read the third of his series of excellent papers on the "World's Columbian Exposition," in which he gave a very full description of the condition of the buildings at that date. This was of especial value as containing the latest information on a subject of peculiar interest to the Society, on account of the Council being constituted the Royal Commission for the British Section. The paper was illustrated by a large number of lantern slides, showing the progress made in the various buildings since the reading of the author's last paper.

Professor George Forbes, well known to the

members on account of his many valuable contributions to the proceedings of the Society, read an important paper on "The Utilisation of Niagara," in which he described the work in course of completion by the Cataract Construction Company for the transmission of power from the great waterfall to the surrounding country.

At the seventh Ordinary Meeting, Mr. Wyke Bayliss, President of the Royal Institute of British Artists, read a paper on the "Fine Arts in Relation to the Sanitary Condition of our Great Cities." He urged the necessity for improving the atmosphere of London, the present impure condition of which was destructive of works of art exposed to its influence. He said that, if sanitarians would improve our great cities, artists would be equal to the occasion, and would produce works worthy of their surroundings.

Mr. William Key read a paper on "The Purification of Air Supplied to Public Buildings and Dwellings," in which he explained a process adopted by him for the purification of the air of buildings by its filtration through a system of wetted screens. In the discussion that followed this paper, Mr. Lorimer spoke in high terms of the value of the system as carried out at the Victoria Hospital, Glasgow, and drew particular attention to the equable temperature maintained in the hospital, both during the coldest nights of winter and the hottest days of summer.

Professor W. N. Hartley, who has on several former occasions favoured the Society with useful contributions on various technological subjects, read a valuable paper, on February 8, on "Some Points in the Chemical Technology of Drying Oils, Oil-boiling, and Bleaching," giving the results of a large amount of research relating to the permanence of oil colours.

At the tenth meeting of the Society, Dr. Frank Clowes read an instructive paper on "The Detection and Estimation of Small Proportions of Fire-damp, Petroleum Vapour, and other Inflammable Gas or Vapour in the Air." Professor Clowes fully described the various safety lamps which had been in use; and, after pointing out the need for detecting small amounts of fire-damp, not actually dangerous, described his portable hydrogen oil safety lamp. In addition to the reading of his paper, Dr. Clowes showed the action of his safety lamp to several inspectors of mines, who were invited by the Society to attend for this purpose.

In a paper on "Old Age Pensions," read on February 22, Mr. T. Mackay fully discussed the question as to the advantages of these pensions, the result of his inquiry being that, in his opinion, the various proposals for dealing with this subject were not satisfactory, and could not be made to work with success.

Mr. T. R. Dallmeyer, on March 1, in a paper entitled "Tele-Photography," described his valuable instrument for the photographing of objects at a great distance. The remarkable results obtained were fully illustrated at the meeting, and excited considerable interest.

Another photographic subject was treated of by Mr. Van der Weyde, in his paper on "The Pictorial Modification of Photographic Perspective," read on April 26. Mr. Van der Weyde described and illustrated by lantern slides his mode of reducing the size of certain portions of the figure which are taken unnaturally large by the ordinary process, and exhibited the particular lenses which he uses.

On March 8, Mr. W. McNaught read a practical paper on "Music in Elementary Schools," which was illustrated by a choir of little girls from the Fleet-road School.

Sir Philip Magnus followed up the various reviews of technical instruction which he has brought under the notice of the Society by reading a paper on "Technical Education: its Progress and Prospects," in which he gave his reasons for believing that a reconstitution of School Boards is necessary, and that the appointment of an Educational Council would greatly help on that improvement of the condition of Technical Education which all hope for in the future.

Mr. Perry F. Nursey read a paper on "The Manufacture of Non-poisonous White-lead," on March 22. He reviewed the various preparations of lead which have been at different times adopted for painting purposes, and specially referred to the assigned value of a particular non-poisonous process now in use.

Mr. Harry W. Chubb read an interesting paper on "The Construction of Locks and Safes," in which he gave an historical account of locks and keys, showing what changes had taken place in the construction of the old iron caskets, which had now developed into the safes of the present day. The paper was illustrated by lantern slides, and a large collection of drawings of artistic metal work, which had been devoted to this branch of manufacture in the past.

Mr. Gisbert Kapp's paper, entitled "Some

Economic Points in connection with Electricity Supply,'' contained valuable data with regard to the cost of electric supply in private installations.

Professor Silvanus Thompson read a paper in which he drew attention to some "Practical Electrical Problems at Chicago." He described that great variety of practice to be found in the United States which would be of special interest to the European electricians about to visit Chicago as differing greatly from what they are used to at home. The Society is much indebted to Professor Thompson for this paper, which he kindly undertook to read at short notice.

Mr. J. H. Hilditch described the new Richmond Lock and Tidal Weir, now in course of construction, in a comprehensive and interesting paper, illustrated by a large number of lantern slides, many of which showed the present condition of the river, and the need for remedial measures.

At the concluding meeting of the Session Mr. F. E. Ives read a paper on "Composite Heliochromy," in which he described his further researches in photography in the colours of nature and the improvements which he has been able to make in his apparatus for showing objects in their natural colours. Capt. Abney, the chairman, expressed his high opinion of the scientific value of Mr. Ives's researches, and his belief that the time would come when lecturers would not be satisfied with monochrome lantern slides, but would expect to have the objects they exhibited shown in their natural colours.

II.—Indian Section.

This Section has had a very successful Session. The meetings have attracted large —in some cases, crowded—audiences; the papers, without exception, have exhibited a high degree of excellence; and the discussions have certainly not fallen below the standard of previous years. In India, it is encouraging to observe, more than usual interest has been displayed in the work of the Section. To reports and comments upon its proceedings, the leading journals in the Presidency capitals have devoted a large amount of their valuable space, while, in some instances, so much importance has been attached to the papers, that they have been reproduced in their entirety. In this, among other ways, the Section is exerting an influence beyond the limits of the Society's roll of Members, and the results can hardly fail to be beneficial. Another fact worthy of notice is the increased desire shown by both official and non-official Anglo-Indians in England to be present, and to contribute to the debates. Of the seven papers read, two were contributed by distinguished men actually in the service of the Crown; and the Society, recognising the value of such contributions, is always anxious to favourably consider offers of papers from competent authorities, still in close touch with the arts, industries, and administration of India. A communication, recently addressed to the Secretary of the Society, affords an indication of the appreciation felt for the Section by experienced and qualified persons. The writer, an English official of standing at the headquarters of one of the provincial Governments, writes:—"I am leaving for India in the course of a few days. Since I have been at home, I have been favoured with several invitations to the meetings of the Indian Section of your Society, and have attended them with interest and advantage. I write to thank you for the opportunities thus afforded me."

The Session opened on January 12 with a valuable paper by Mr. Herbert Thirkell White, of the Imperial Civil Service, on "Upper Burma under British Rule." The paper was valuable, not only as an authoritative description of the occupation and settlement of the newly-acquired territory, but as showing that our representatives in the East at the present day are, in valour and devotion to the British flag, the equals of their predecessors. Distinction was added to the meeting by the presence, in the chair, of the new Commander-in-Chief in India, Sir George White, who happened to be in England at the time on short leave, and who was able to explain, with more clearness than had been done previously, the causes and effects of our acquisition of Burma. Sir George White's speech, delivered from the soldier's point of view, was rightly regarded as a fitting complement to Mr. Thirkell White's paper, which necessarily was concerned more with civil than with military matters, and excited no little notice in the columns of the Home and Indian Press. In the discussion, the audience had the advantage of hearing the question of the annexation of Upper Burma debated from various aspects—Sir Charles Bernard, a former Chief Commissioner of Burma, representing the administrative, Mr. J. Annan Bryce, who has been long connected with the trade of Burma, the commercial, and Mr. Taw Sein Ko, an accomplished Burman, the native view. Subsequently General Sir Harry

Prendergast and others availed themselves of the opportunity of expressing their opinions in the columns of the Society's *Journal*.

On January 19 Mr. J. Barr Robertson read an extremely able and exhaustive paper on "The Currency Problem," in which, by means of a series of carefully-prepared tables, he explained the movements in gold and silver prices during the past twenty-five years, and argued that the final triumph of bimetallism is inevitable. The discussion which followed extended over a second meeting of the Section. On February 16, an admirable paper on "The Progress of India under the Crown" was read by Sir William Wilson Hunter, whose eloquent summary of the results of our rule in Asia embraced a graphic account of the steps taken by the Government of India under Sir Donald Stewart and Lord Roberts to secure the internal safety of India as well as the defence of her extensive North-Western frontier. Equally suggestive were his remarks on the advances made in the well-being of her Majesty's Asiatic subjects. He held that marvellous as has been the material progress of India under the Crown, its moral and intellectual development has been still more significant. On March 9 Mr. Baines followed up the excellent paper he wrote last year by one of no less ability on "Occupation and Caste in India, as shown in the last Census." The lucid manner in which the author dealt with the subject has increased the interest with which the public are awaiting his report on the great work which, as Imperial Census Commissioner for India, he is now bringing to a close. On April 6, Sir Edward Braddon read a paper of much literary merit and practical value on "Australasia as a Field for Anglo-Indian Colonisation." The author invited Anglo-Indians—of whom, as he reminded the meeting, he was formerly one—to consider whether Australasia would not suit them better than England as a scene for their retirement, because of the following advantages offered to them there:—(1) a finer climate; (2) living so much cheaper that luxuries, here unattainable, may be enjoyed out there; (3) a chance (in some colonies the certainty) of obtaining congenial and sometimes remunerative occupation; (4) a field for more profitable employment of capital; and (5) a wider opportunity for the career of sons. The Agent-General for New Zealand (Mr. W. B. Perceval), Lord Stanley of Alderley, Sir Raymond West, and several other gentlemen, took part in the discussion. On April 24, Sir Juland Danvers, K.C.S.I., read a paper on "The Manufactures of India; their State and Prosperity." Both the paper and discussion on it deserve to be studied by all who are interested in the industrial development of our Indian Empire. The final meeting took place on May 18, when Sir James Fergusson, M.P., presided, and Sir Raymond West read a learned and comprehensive paper on a subject that has lately been investigated by a special Commision, and is now awaiting the matured judgment of the Government, namely, "Agrarian Legislation for the Dekhan, and its Results." Sir J. B. Richey, who takes a more hopeful view of the Dekhan Agriculturists' Act, of which he was the virtual author, than does Sir Raymond West, being unfortunately prevented by ill-health from opening the discussion, his place was taken by a gentleman of unique experience in the working of the Act, Dr. A. D. Pollen, of the Imperial Civil Service. The Chairman, as well as Sir James Lyall, ex-Lieutenant-Governor of the Punjab, and Sir W. Wedderburn, M.P., took part in the discussion.

III.—Foreign and Colonial Section.

Six papers have been read before this Section during the present Session. On January 17th Mr. E. J. Howell described the resources of Mexico. The reader gave his views as to the origin of Mexican civilisation, and the chairman, Sir Edward Jenkinson, in the course of his remarks, dwelt at some length on this interesting but obscure subject. On February 28 a paper was read by Sir Edward Braddon on "Russia, as a Field for Tourists," wherein he gave his experiences of a trip to St. Petersburg and Moscow in connection with the Railway Congress of 1892, and described the attractiveness of a holiday spent in these cities. On March 21 Mr. Cecil Fane read a paper on "Newfoundland," in which he traced the history of this our earliest colony and described its various industries. He gave special prominence to the subject of the Fisheries, which form by far the most important trade, and drew attention to the vexatious restrictions which hamper them, owing to the ancient treaties with France. On April 18 Mr. H. A. McPherson read a paper on "The Philippine Islands." Their history, products, and resources were amply treated, and views of the scenery were shown. The paper read at the meeting held

on May 2 was entitled "Russian Industrial Art," and the reader, Mr. E. Delmar Morgan, described the present condition of the various native industries of Russia, many specimens being exhibited. Striking figures were given to show the rapid growth of the cotton trade, which now forms the principal native industry. The last paper of the Session was read on May 16, and was entitled "Aspects of Imperial Federation from a Colonial Point of View." The reader, Mr. W. B. Perceval, Agent-General for New Zealand, set forth the various points which, in his opinion should be first considered in framing a scheme of Federation, and advocated the holding of a conference for the purpose of discussing them. The Earl of Onslow, who presided, described the policy which guided the Government in summoning the Conference of 1887, and concurred with the reader in thinking that the time was ripe for a further conference to be convened.

IV.—Applied Art Section.

At the First Meeting of this Section, on January 24, Mr. Hugh Stannus, read an interesting paper on "The Theory of Storiation in Art," and learnedly set forth the principles upon which works of art could be made to tell the story of their design.

At the February Meeting, Mr. Wilton P. Rix read a paper on "Pottery Glazes: their Classification and Decorative Value in Ceramic Design," in which he gave an instructive account of glazes, and attempted an explanation of the causes of the beautiful artistic effects resulting from their use.

At the Third Meeting, Mr. T. R. Spence gave an interesting account of the history of "Wall-papers and Stencilling," which was illustrated by a fine collection of English wall-papers, kindly lent by some of the principal makers. In the discussion that followed the reading of the paper the fact was well brought out that in this branch of design England is ahead of the world.

Herr Paul Schulze, of Crefeld, who has made a special study of the history of design in the textile industry, was so good as to come to this country specially for the purpose of reading a paper on "The History and Development of Pattern Designing in Textiles," and his paper, which was read on April 11, was illustrated by a large number of lantern slides which showed examples of designs from the earliest times. In the discussion, Mr. Sparkes pointed out the great value of this form of illustration, the use of which he thought might be extended largely, so that the contents of museums could be made available to students in a way that they had not hitherto been.

Prof. W. M. Flinders Petrie read, on May 9th, a remarkable paper on "Primitive Art in Egypt," and gave an account of his original discoveries in this rich field of archæological and artistic research.

Mr. Horace Townsend concluded the work of the Session with a useful paper on "American Silverwork," in which he urged that, in the designing of silver objects for domestic use, the silversmith of the United States was far in advance of the British silversmith. Mr. Townsend drew special attention to the fact that, while nothing had been done in England to utilise the knowledge of Japanese processes, given to the world by Prof. Roberts-Austen through this Society, Messrs. Tiffany had largely availed themselves of these processes, and had produced some remarkable examples of beautiful design by the use of Japanese alloys.

V.—Cantor Lectures.

During the Session five courses of Cantor Lectures on scientific and artistic topics were delivered. The course before Christmas was on the "Generation of Light from Coal Gas," by Professor Vivian B. Lewes, and the lecturer gave in his four lectures an interesting history of the production of gas and the changes made in the burners used for the purpose of improved illumination. He was followed, after Christmas, by Dr. J. A. Fleming, who, in a course of four lectures, kept a large audience deeply interested in his account of the "Practical Measurement of Alternating Electric Currents" by his brilliant exposition of a somewhat abstruse subject. The instruments exhibited by Dr. Fleming in illustration of his lectures were numerous and of great value.

Professor Roberts-Austen, in a course of four lectures, continued the exposition of his important series of researches on "Alloys." The experiment was made on the occasion of the delivery of these lectures of holding the meetings at five o'clock, instead of at the usual hour of eight. The attendance was good, and it may in the future be found acceptable to the members if one of the courses is given in the afternoon, for the convenience of those who are not able to attend evening meetings.

Mr. Lewis F. Day, in his four lectures on

"Some Masters of Ornament," gave a full and satisfactory account of the works of foreign ornamentists during several centuries, and the selection of specimens of the work of these artists, which were shown as lantern views, was very fine.

Another course on an artistic subject was by Mr. C. Harrison Townsend, in two lectures, on the "History and Practice of Mosaic," which were delivered in May, and completed the series for the Session. Mr. Townsend's first lecture, which was profusely illustrated, was historical, and contained an instructive description of the chief mosaics of the world, while the second was devoted to an enunciation of the proper principles to be observed in the production of mosaics. Mr. Townsend considers that the present practice in Italy and France is unsound, but that in England much good work is being done. He called attention to the fact that many of the grand mosaics of Italy are now being heedlessly destroyed, and urges those who wish to see the works of the masters of the art to lose no time in visiting that country.

VI.—Juvenile Lectures.

The usual short course for a juvenile audience was last Christmas delivered by Dr. Bowdler Sharpe, who gave two very interesting lectures on the "Curiosities of Bird Life," illustrated by an original series of drawings of birds by Mr. Keuhlemans, which was highly appreciated by a large audience.

VII.—Howard Lectures.

The special course of six lectures under the Howard bequest, which was announced for delivery in 1892, but was unavoidably postponed on account of Professor Unwin's illness, was delivered in January and February of the present year. The subject was "The Development and Transmission of Power from Central Stations," and Prof. Unwin gave an exhaustive account of the various means of developing and transmitting power as at present applied in different countries.

VIII.—Albert Medal.

His Royal Highness the Prince of Wales (President) and the Council of the Society have awarded the Albert Medal for the present year to Sir John Bennet Lawes, Bart., F.R.S., and a like Medal to John Henry Gilbert, Ph.D., F.R.S., for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted.

IX.—Medals for Papers.

The Council have awarded the Society's Silver Medal to the following readers of Papers during the Session 1892-93 :—

At the Ordinary Meetings :—

To James Douglas, for his paper on "The Copper Resources of the United States."

To William Key, for his paper on "The Purification of the Air Supply to Public Buildings and Dwellings."

To Prof. Frank Clowes, D.Sc., for his paper on "The Detection and Estimation of small proportions of Inflammable Gas or Vapour in the Air."

To Thomas R. Dallmeyer, for his paper on "Tele-photography."

To Gisbert Kapp, for his paper on "Some Economic Points in connection with Electric Supply."

To H. Van Der Weyde, for his paper on "The Pictorial Modification of Photographic Perspective by the use of the Photo-Corrector or Visual Lenses in Portraiture and Landscape."

In the Indian Section :—

To Herbert Thirkell White, I.C.S., C.I.E., for his paper on "Upper Burma under British Rule."

To J. Barr Robertson, for his paper on "The Currency Problem."

To Sir Juland Danvers, K.C.S.I., for his paper on "Indian Manufactures: their present State and Prospects."

In the Foreign and Colonial Section :—

To Cecil Fane, for his paper on "Newfoundland."

To H. A. McPherson, for his paper on "The Philippine Islands."

To W. B. Perceval, Agent-General for New Zealand, for his paper on "Aspects of Federation from a Colonist's Point of View."

In the Applied Art Section :—

To Hugh Stannus, F.R.I.B.A., for his paper on "The Theory of 'Storiation' in Art."

To Wilton P. Rix, for his paper on "Pottery Glazes: their Classification and Decorative Value in Ceramic Design."

To Prof. W. M. Flinders Petrie, for his paper on "Primitive Art in Egypt."

Thanks have been voted to the following members of the Council :—

To Sir Edward Braddon, K.C.M.G., Agent-General for Tasmania, for his papers on "Australasia as a Field for Anglo-Indian Colonisation," and "Russia as a Field for Tourists."

To James Dredge, for his paper on "The Chicago Exhibition, 1893."

X.—Mulready Prizes.

The Council have awarded the Mulready Prize of £20 (on the adjudication of the examiners of the Science and Art Department) to Laura Margaret Fisher, of the Clapham School of Art, Vernon-road, Clapham, S.W., who obtained from the Science and Art Department a Gold Medal for a finished drawing, of imperial size, from the nude living model; a book prize for studies of hands and feet in the National Competition; and a 2nd Class for her Third Grade Examination in drawing from the living model.

The offer of a prize for £20, or a Gold Medal, under the Mulready Trust, has been repeated for the present year for competition among the students of schools of art in the United Kingdom for drawings from the nude. The Science and Art Department have consented to assist the Society, by allowing the adjudication to be made by their examiners.

XI.—John Stock Prize.

A Gold Medal, or a Prize of £10, has been offered, under the John Stock Trust, by the Council to the student of a School of Art who shall send in, at the competition of 1893, the best original design for the decoration of the apse or side of the chancel of a church, or any suitable part of the interior of a building, by means of wall-painting, stucco, carving, mosaic, or any other process. This prize was offered last year, but was not awarded, and the Council have renewed the offer, on the recommendation of the Science and Art Department, whose examiners will, as in the case of the Mulready Prize, make the adjudication.

XII.—Owen Jones Prizes.

Prizes for the best designs for household furniture, &c., on the principles laid down by Owen Jones, have been awarded annually, since 1872, on the results of the annual competition of the Science and Art Department, to students of the Schools of Art. Six prizes were, as usual, offered last year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze Medal. A list of the successful candidates has appeared in the *Journal*.* An equal number of prizes has been offered for the present year (1893), and the result of the competition will be published in the *Journal* as soon as it is received from the Science and Art Department.

* See *Journal*, November 11, 1892.

XIII.—Prizes for Drawing.

The Council have, for the past four years, offered twelve Bronze Medals for drawings sent in by students to the annual exhibition held by the Royal Drawing Society, which, during the five years of its existence, has greatly stimulated the teaching of drawing in upper schools. The fourth annual exhibition in 1893 showed how many different kinds of drawing are useful in developing this Society's plan of making drawing a means of general education. The exhibition consisted of 924 drawings by about 650 boys and girls selected from nearly 20,000 in 120 public schools, high schools, and grammar schools. Special awards were given this year to the great public schools. Of these 18 sent drawings, which were judged by Sir Frederic Leighton, P.R.A., Sir James D. Linton, P.R.I., and Sir Douglas Galton, K.C.B., for technical and machine drawing. In addition to the carrying out of the work of the exhibition, the society holds annual examinations for schools, and awards certificates to competent teachers. The Council, being desirous of helping the work which this society is doing by encouraging the study of drawing in the highest and middle-grade schools, have acceded to an application for the renewal of the offer of medals for next year.

XIV.—Examinations.

That the popularity of the Society's examinations is steadily increasing is evidenced by the experience of the present year. In no year since the establishment of these examinations have so many candidates presented themselves, and it is interesting to compare the figures of this year with those of 1869, when the largest number of candidates were examined under the old system of permitting students at institutions in union with the Society to be examined free. In that year, with 36 subjects of examination, 2,160 candidates worked 3,193 papers, of which 1,118 were rejected. In the present year, with only 18 subjects, 3,702 candidates worked 3,916 papers, only 819 of which failed to obtain certificates. The number of papers worked last year was 3,143, hence there is this year an increase of 773. In 1870, examinations were discontinued in 17 out of the 36 subjects, namely, those subjects in which the Science and Art Department was also examining candi-

dates, and as to which there was, in this duplication of examination, an evident waste of power; and many modifications were made in the scheme during the next few years; but, since 1883, when the existing system was adopted, the numbers have steadily increased, until the satisfactory results above recorded have been reached.

The prizes offered by the Clothworkers' Company, as well as those offered by the Council—from the funds placed at their disposal by the Goldsmiths', Mercers', Skinners', and Salters' Companies—have been awarded, with the exception of those for Portuguese, in which subject no candidate was examined; and it is evident that the offer of these prizes is a great incentive to candidates to attend the Society's examinations.

XV.—Practical Examinations in Music.

The number of candidates, which had fallen from 276 in 1891 to 249 last year, has this year shown a satisfactory increase, 312 candidates having presented themselves for examination—the largest number examined since the foundation of the scheme. Ten candidates having entered for two subjects, there were 322 examinations, resulting in the award of 129 First-class and 155 Second-class Certificates, while only 38 were failures. The examiners, Sir Joseph Barnby and Mr. W. G. McNaught, were much pleased with the ability and evidence of careful study shown by most of the candidates, and they were enabled to award 35 medals, that being the number of those who obtained full marks.

XVI.—Chicago Exhibition.

In the 1892 report an account was given of the work which the Council in its capacity as the Royal Commission for the Chicago Exhibition, had carried out up to the date of the last annual meeting.

In June, 1892, the Secretary, Sir Henry Trueman Wood, paid a visit to Chicago, in order to make final arrangements for the allotment of space to Great Britain, and for other matters. The results of this visit are embodied in a report which appeared in the *Journal* of August 5, 1892 (vol. xl., p. 837). As a result of the negotiations then carried on, and by subsequent correspondence, a total area within the Exhibition buildings was allotted to the United Kingdom and British possessions of about 500,000 square feet, of which over 300,000 was assigned to Great Britain. The manner in which the space is distributed among the various buildings of the Exhibition is shown in the following Table:—

	square feet.
Agriculture	13,776
*Horticulture	656
Fisheries	650
Mines and Mining	8,000
Machinery	40,000
Transportation (including Annexe and Gallery)	54,257
Manufactures	100,400
Liberal Arts (Gallery of Manufactures Building)	59,560
Electricity	5,858
Woman's Building	2,384
Forestry	1,000
Fine Arts	20,325
Total	306,866

Besides this amount, spaces have been assigned in the grounds of Jackson-park for the Victoria House, and for certain special exhibits.

The 188,000 square feet assigned to the Colonies and India was divided, approximately, as follows:—

	square feet.
Canada	100,600
New South Wales	50,000
Cape Colony	4,000
Ceylon	22,000
British Guiana	500
Jamaica	5,000
Trinidad	500
India	2,584

The Government of India did not at first propose to take any part in the Exhibition, but eventually they made a grant of 40,000 rupees to the Indian Tea Association, to assist them in exhibiting Indian Teas, and a grant of 10,000 rupees to Messrs. Tellery, of Delhi, to aid in the formation of a representative collection of Indian Art Ware. They have also prepared and sent a small collection of Indian Forest Products. There are, moreover, several independent Indian exhibitors. The exhibits of the Tea Association and of Art Ware shown by Messrs. Tellery, are placed in a pavilion specially erected in the grounds.

New South Wales, Canada, and Ceylon, have special buildings all adjacent to Victoria House.

The external work of Victoria House, a description of which was given in the last Report of the Council was completed before

* The space in the Horticultural Building was eventually surrendered to the Executive in consequence of the withdrawal of the exhibitors to whom it had been allotted.

the winter. The internal fittings and furniture were made in England by Messrs. Johnstone, Norman & Co., and were despatched early in the new year to Chicago, and the fitting up of the house was completed under their direction.

Owing to unforeseen delays the work was not finished until the end of the third week in May, though it was sufficiently advanced for the offices to be used for some time before the opening of the Exhibition.

In connection with this subject the Council have to express their sense of the great loss which they suffered by the sudden death of Colonel Grover, who had returned to Chicago in the autumn to superintend the construction of the house, and to act in other respects as the representative of the Commission. Colonel Grover's death took place, as has already been announced in the *Journal*, on the 29th of January.

The assignment of space in the various buildings to the British exhibitors commenced in May, 1892, and the notices of allotment were mostly issued by November. New applications, however, were received up to the latest possible dates; and, owing to frequent changes, and to the fact of various exhibitors—who had accepted the space provided for them—withdrawing, constant alterations have been necessary, even after the opening of the Exhibition. In the case of the Fisheries Department, the grant of space was not received from the American Executive until March, 1893, and, consequently, the issue of allotments to the few exhibitors in this department was delayed.

The number of exhibitors in the different departments is as follows :—

Department A,	Agriculture and Food	71
,,	*B*, Horticulture	17
,,	*C*, Live Stock	2
,,	*D*, Fish and Fisheries	11
,,	*E*, Mines and Mining	33
,,	*F*, Machinery	46
,,	*G*, Transportation	76
,,	*H*, Manufactures	184
,,	*J*, Electricity	8
,,	*K*, Fine Arts	507
,,	*L*, Ethnology (Women's Work)	1,074
Indian Exhibits		15
		2,044

As in the case of many previous Exhibitions, this number does not appear to compare favourably with the number of exhibitors in many foreign countries, but this is to a large extent due to the fact that in other countries than Great Britain, there are frequently large collective exhibits, the individual contributors to which all appear in the General Catalogue, although their exhibits, in many cases, may occupy only a very small area. It may be noted that the largest number of the British exhibitors appears to be that of the Women's Section.

Sir Henry Wood left England in February, in order to assume the position of Chief Executive Officer of the Royal Commission, and he arrived at Chicago on March 6th. The work has been particularly heavy, and very special difficulties have been attendant upon it, but thanks to Sir Henry Wood's great experience, and his cordial relations with the Exhibition Executive, the Council is pleased to report the results to be eminently satisfactory.

The Secretary was preceded by Mr. Lloyd, the Assistant - Secretary, who, fortunately, reached Chicago a very few days after the sudden death of Colonel Grover, and was, therefore, able to take up and carry on his work without serious interruption.

The Secretary has reported in the most favourable terms on the manner in which Mr. Lloyd has carried out the very arduous and difficult duties entrusted to him, and of the energetic way in which he has devoted himself to the work; and he also reports most favourably upon the conduct of the whole staff, which is as follows :—

Executive Staff in Chicago.

Sir Henry Trueman Wood, M.A., Secretary to the Royal Commission.

Edmund H. Lloyd, Assistant-Secretary and General Superintendent.

Ralph A. Harbord, Private Secretary to Sir Henry Wood.

J. W. Beck, Superintendent of Fine Arts.

E. H. Fishbourne, M.A., Superintendent of Manufactures and Liberal Arts.

H. D. Wilkinson, M.I.E.E., Superintendent of Machinery.

Thomas Baker, Superintendent of Transportation.

H. W. Pearson, Superintendent of Agriculture.

T. G. Dundas, Assistant Superintendent for Traffic Arrangements.

Edward F. Bird, Accounts Clerk.

J. Bowdidge, Draughtsman.

H. J. Dack, P. Harper, A. J. Beck, J. D. McKinlay, T. J. Christie, Clerical Assistants.

The large area of Jackson-park, and the fact that the British exhibits are distributed through nine separate buildings (exclusive of the Women's Building), has rendered necessary a somewhat numerous staff.

The Exhibition was opened on the 1st May, in accordance with announcements, although it was, as has been frequently the case with other Exhibitions, in a very backward condition. This is to a very large extent to be attributed to the bad weather of the winter, which not only seriously interfered with the constructive work, but caused considerable damage to many of the buildings, which had to be repaired before exhibits could be safely installed.

The British Section was, it is gratifying to be able to report, by far the most advanced of any of the Sections, including that of the United States. A very large proportion of the exhibits were complete by the opening, although there remained a good deal to be done during the first fortnight in May. Most of the other countries had undertaken the construction of elaborate and costly pavilions, for the reception of their exhibits, within the buildings. There can be no doubt of the superior attractiveness of this method, although it may be a question whether it has not been carried to excess at Chicago, and whether the general effect of the main building has not seriously suffered from its being filled up with these interior buildings. As at all former Exhibitions, it was left to British exhibitors to erect such stands as they thought proper, provided they complied with the conditions laid down by the American Executive and the Royal Commission; and it is satisfactory to be able to state that the freedom accorded has produced most admirable results. The pavilions set up in the Manufactures Building, by Messrs. Doulton & Co., Messrs. Hampton & Sons, and the Goldsmiths' and Silversmiths' Company, have won great attention, and they are only a few among the many beautiful and attractive structures with which the British Section in that building is provided.

The selection of the pictures to represent the British school, and the arrangements for their transport to Chicago and exhibition there, were left in the hands of the Fine Arts Committee, of which Sir Frederick Leighton is the President and Mr. J. W. Beck the Secretary, afterwards appointed Superintendent of the Department. Invitations were addressed to a large number of distinguished artists, asking them whether they wished to contribute to this section, and if so, to give the titles of the pictures by which they desired to be represented, To these invitations very satisfactory responses were received, and steps were then taken to obtain from their owners the loan of the pictures designated. A date was also fixed for the reception of pictures from other than the invited artists, in order that they might be submitted to the judgment of the Committee. The governing body of the Imperial Institute kindly provided accommodation in their new building at South Kensington for the reception and packing of the pictures, and the assistance thus rendered to the Commission was of the utmost value.

The efforts of the Fine Art Committee, ably seconded by the energetic Superintendent of this Department, Mr. J. W. Beck, have resulted in the transmission of a collection of British pictures to Chicago which is acknowledged to be superior to that contributed to this or to any previous Exhibition.

In Machinery, our exhibits are, for obvious reasons, not equal in number to those sent to previous International Exhibitions. Prominent among those which have been sent may be mentioned Messrs. Galloway's engine, and the fine exhibit of cotton-cleaning, carding, and combing machinery by Messrs. Platt Bros.

In the Electricity Building, the most important contribution is the collection of ancient and modern telegraphic apparatus, lent by the Post-office.

In the Mines Building, the most remarkable contributions are those sent by the British Colonies, especially by Canada and New South Wales.

The area in the Agricultural Building, in which are placed all the Food Exhibits, is well and creditably filled. Messrs. Crosse and Blackwell occupy the most prominent part here.

Another attractive exhibit is the model of the Brookfield Stud Farm, shown by Mr. Burdett-Coutts.

Some of the most important and interesting of exhibits in the British Section are contained in the Transportation Building. The collection of ship models, headed by the model of the ill-fated *Victoria*, shown by Messrs. Armstrong, Mitchell, and Co., is certainly the finest at Chicago; and our Railway Exhibit, including, as it does, a London and North Western engine and two carriages, and the broad gauge engine, the "Lord of the Isles," sent by the Great Western Railway, compares favourably even with the magnificent display made by the American railways.

The exhibits belonging to the Department of Liberal Arts are shown in the gallery of the Manufactures Building. These include the London School Board Collection, illustrative of

the condition of elementary education in England; the collection of the works by students of the Science and Art Department; Messrs. Tooth and Son's fine exhibit of engravings; the exhibit of the Ordnance Survey; the Geological Survey; the collection of photographs referred to below, &c.

The Women's Committee, under the presidency of H.R.H. Princess Christian, have had control of the arrangements of the Women's Section, a grant for the purpose of defraying the expenses having been placed at their disposal by the Commission. The work in this section has been mainly done by sub-committees, whose action was supervised by the General Committee, of which Miss Lankester, of the National Health Society, is the Secretary.

The Commission are greatly indebted to Mrs. Roberts-Austen and Mrs. Bedford-Fenwick, who went over to Chicago in April, and having organised the work of that department, have just returned to England. It may be mentioned that the British Section in the Women's Building was the only one complete on the day of opening.

The question of a Live Stock exhibit from this country received a great deal of attention from the Agricultural Committee, which was presided over by the Earl of Feversham, President of the Royal Agricultural Society. Mr. Ernest Clarke, the Secretary of the Society, is the honorary secretary of the Committee, which has held many meetings at the rooms of the Society in Hanover-square, London. The programme of the proposed Live Stock Exhibition was carefully considered by a sub-committee, and a number of suggestions, which it was thought would facilitate the transmission of British live stock, were made to the Executive at Chicago. Some of these suggestions were acted upon, but others do not seem to have commended themselves to the Department of Agriculture. The difficulties attendant upon the transport of live stock to such a distance, and especially the necessity for keeping them in quarantine for a period of ninety days, have prevented many intending exhibitors from making application.

A special Committee, with Mr. Francis Cobb as its chairman, and Mr. F. Seyton Scott as its secretary, was appointed to organise a loan collection of photographs, illustrative of the present position of the art in this country. In order to insure a thoroughly representative collection, invitations were addressed to the principal photographic artists in Great Britain, and in nearly every case a promise to exhibit was received. This collection is shown, as above stated, in the Department of Liberal Arts, a small gallery having been specially constructed for the purpose.

In addition to the contributions from exhibitors in the various departments of the Exhibition, the Commission have received a number of loan exhibits. Excluding the Fine Art Department, the pictures in which are really loan exhibits, these include the Photographic collection above mentioned; an exhibit of Educational Apparatus and specimens, formed by the School Board for London; a similar exhibit by the Science and Art Department; and collections formed by the Ordnance and Geological Surveys.

There is exhibited in the Mines Department a collection of Economic Minerals, specially formed on behalf of the Commission by Mr. Bennett H. Brough, and a collection illustrating British Metallurgy, formed by Dr. E. J. Ball.

The banners lent by 76 Corporations of the United Kingdom form an interesting addition to the decorations of the British Section in the Manufactures Building. Each of these banners displays the armorial bearings of one of the ancient municipalities. Many of the banners, including several lent by the ancient City Companies, have been specially prepared for the occasion.

In January, 1892, the Commission published a "Handbook of Regulations" including information relating to the Exhibition generally, and the British Section in particular. Of this, successive editions were issued in April, June, August, 1892, and in January and May, 1893, increasing in size from 64 to 228 pages. The last edition contained a list of the Royal Commission, and the Committees appointed by them; a synopsis of the classification; the regulations issued by the Chicago Executive, the United States Customs, and the British Commission; information as to cost, &c., of freight; an abstract of the United States Tariff; information as to routes to Chicago; brief descriptions of the Exhibition and the various buildings; and much other general information, such as seemed likely to be useful to Exhibitors and to visitors.

With the view of adding to the interest and to the permanent value of the Catalogue, the Commission arranged that each Section should be prefaced by a short introduction, and they were fortunate enough to secure the assistance of the following eminent authorities in the

preparation of these introductions:—Agriculture, Ernest Clarke, F.S.A., Secretary of the Royal Agricultural Society; Food, &c., R. Bannister, F.C.S.; Horticulture, W. Thiselton Dyer, C.M.G., F.R.S., Director of the Royal Gardens, Kew; Live Stock, Ernest Clarke; Sea Fisheries, Professor E. Ray Lankester, F.R.S.; Angling, R. B. Marston, Editor of the *Fishing Gazette*; Mining, Professor C. Le Neve Foster, D.Sc., F.R.S., H.M. Inspector of Mines; Metallurgy, Prof. W. C. Roberts-Austen, C.B., F.R.S., Chemist to the Mint; Machinery, H. Graham Harris, M.Inst.C.E.; Ships, Prof. Francis Elgar, LL.D.; Railways, Sir Douglas Galton, K.C.B., F.R.S.; Common Road Carriages, George N. Hooper; Bicycles and Tricycles, George Lacey Hillier; General Manufactures, Reginald H. Hooker, B.A., Assistant Secretary of the Statistical Society; Textiles, Swire Smith; Pottery, Wilton P. Rix; Electricity, Professor W. E. Ayrton, F.R.S.; Fine Arts, J. E. Hodgson, R.A., Professor of Painting to the Royal Academy of Arts; Education, J. G. Fitch, M.A., H.M. Chief Inspector of Schools; Music, J. A. Fuller Maitland; Photography, Captain W. de W. Abney, C.B., F.R.S., Assistant Director of the Science and Art Department; Scientific Apparatus, Professor Silvanus Thompson, F.R.S.; India, Samuel Digby, Secretary of the Indian Section of the Society of Arts.

The cover for the Catalogue was specially designed by Mr. Lewis F. Day, by whom the Royal coats-of-arms and the ornamental shields which have been used in the decorations of the various parts of the British Section were also designed.

XVIII.—Chicago Exhibition—Congresses.

A large number of Congresses have been arranged to be held in connection with the Exhibition, from May to October, and the Royal Commission were asked by the Secretary of State for Foreign Affairs to appoint distinguished men to act as delegates at these conferences. Invitations were sent to the chief scientific and other societies asking them to nominate suitable men, and the Royal Commission have communicated to the Foreign-office a list of delegates for transmission to the Chicago Executive by the United States Ambassador, through whom the invitation was made to the Royal Commission.

XIX.—Chicago Exhibition—Judges.

The arrangements made in connection with the medals to be awarded at the Exhibition were of a novel character. The report of the Director-General upon the whole question was printed in the *Journal* of the Society in December, 1891. Since then the full regulations have been issued, and the latest edition of these was published in the number of the *Journal* for March 10th last. In the Director-General's original report it was proposed that $130,000 should be set aside to pay the Judges, but nothing further was said with regard to payment in the printed regulations. It was long before definite information was received by the Royal Commission as to the payment of Judges, and also as to the number that would be allowed to Great Britain. It was finally settled that forty Judges would be allotted to each of the three chief European Powers—Great Britain, France, and Germany—irrespective of the number of their relative exhibits, and that $750 would be paid to each Judge appointed. In addition to the forty Judges allowed for Great Britain, three ladies have been appointed as Judges for the Women's Section. Some difficulties as to the working of the regulations have arisen; but it is believed that these difficulties have, to a great extent, been overcome, and that important modifications will be made in the regulations. The Royal Commission have selected a number of distinguished men who have consented to act as Judges, and it is understood that the work, which was to have commenced on June 15th, and was then postponed to July 1st, has now been definitely fixed for July 15th.

XX.—New Council.

The five Vice-Presidents who retire this year are Dr. W. Anderson, Sir Owen Tudor Burne, Lord Alfred Churchill, Mr. Wyndham Portal, and Sir Robert Rawlinson; and the Members of Council whose period of service comes to an end are Mr. A. B. W. Kennedy, Mr. W. H. Preece, and Sir Saul Samuel. Sir Owen Roberts also retires from the Treasurership, in accordance with the Bye-laws, as he has served that office five years. One vacancy occurs among the Members of Council through the lamented death of Mr. Alfred Carpmael. To fill the vacancies among the Vice-Presidents, the Council propose for election Lord Kelvin, President of the Royal Society, the Lord Mayor, and Mr. Herbert C. Saunders, Q.C., who have not previously held office on the Council. Mr. Preece and Sir Saul Samuel are added, on their retirement, as Members of Council. Mr. George Ledgard Bristow, one

of the partners of the late Mr. Carpmael in the firm of Messrs. Wilson, Bristow, and Carpmael, honorary solicitors to the Royal Commission, Mr. John O'Connor, Mr. Florence O'Driscoll, M.P., and Mr. Westby B. Perceval, Agent-General for New Zealand, are proposed as Members of the Council. Mr. John O'Connor has filled the Vice-Presidentship, but none of the other three have previously held office in the Society. Mr. Perceval will be known to the members as having read an interesting paper on "The Aspects of Federation from the Colonist's point of view," in the Foreign and Colonial Section. Dr. William Anderson, on his retirement from the Vice-Presidentship, has been placed on the balloting list as Treasurer.

By authority of the temporary Bye-laws passed at the general meeting held on Wednesday, 18th May, 1892, the newly-elected Council can add five additional Vice-Presidents to the Council for the coming year. Sir Richard Webster, Chairman of the Council, was, at the last annual meeting, elected Vice-President for two years, in accordance with this Bye-law.

XXI.—Soane Museum.

By the Act of Parliament under which Sir John Soane's Museum was established in 1833, it was provided that Trustees should be nominated by certain bodies of which the Society of Arts is one. A Trustee has to be elected every five years, and the period of election came round last year, when the Council elected Sir Benjamin Ward Richardson, M.D., F.R.S., who has acted as the Society of Arts Trustee for two periods of five years. The Council now place his name on the balloting list and recommend him for re-election.

XXII.—Conversazione.

The *conversazione* will be held this year at the Imperial Institute, on Friday evening, June 30, when the whole of these important new buildings will be placed, by the courtesy of the Council of the Institute, at the disposal of the Society. The Council believe that the members will appreciate an arrangement by which they are enabled to meet in a place so specially adapted to the purposes of a public reception.

XXIII.—Obituary.

The Society has sustained some severe losses by death during the past year, and obituary notices of the more prominent members who have died during 1892-3 will be found in the columns of the *Journal*. Foremost amongst those whose loss the Society has to deplore must be mentioned Mr. Alfred Carpmael, who sat on the Council with a break of a single year, since 1882. His death after a short illness, and so soon after he had represented the Royal Commission at the Dedicatory Ceremonies at Chicago, was felt to be an irreparable loss. Sir Richard Owen, the distinguished naturalist of world-wide fame, who died at an advanced age, was elected a member of the Society so long ago as 1855. The Earl of Derby took considerable interest in the work of the Society, and held the office of Vice-President for several years. The Duke of Sutherland and Lord Winmarleigh, who was better known as Colonel Wilson Patten, were both members of forty years standing. Mr. Vicat Cole, R.A., the eminent landscape painter, was elected on the Council in 1885, and served for several years. Dr. Longstaff, who died in September last at the age of 93, held the office of treasurer to the Society from 1863 to 1865. Sir William Mackinnon, Bart., C.I.E., had been a life member since 1884. Dr. Forbes Watson read several important papers before the Society, the earliest of which was contributed as far back as the year 1857. Other well-known members of the Society whose names should be mentioned here are Mr. Edward Graves, Engineer-in-Chief of the Telegraph Department of the Post-office, who was also an active member of the Electricity Committee appointed for the Chicago Exhibition. Mr. Mattieu Williams, F.C.S., was well-known to the members from having given several valuable series of Cantor lectures. Sir George Findlay, manager of the North Western Railway, read a valuable paper before the Society on "Modern Improvements and Facilities in Railway Travelling," in 1890. The last two members to be mentioned were both intimately connected with Atlantic telegraph cables. Mr. Cyrus Field, the successful promoter of these cables was a life member of the Society since 1876, and Sir James Anderson, who was in command of the *Great Eastern* when the first Atlantic cable was laid, was elected in 1872.

XXIV.—Finance.

The annual financial statement continues to prove the satisfactory position of the Society, the receipts being well maintained. This is

the more satisfactory as it shows that, notwithstanding the large number of institutions of a kindred nature now established in London, the work of the Society of Arts is so well appreciated as to secure a steady continuance of public support. The statement of receipts, payments, and expenditure during the past year was published, in accordance with the Society's bye-laws, in the last number of the *Journal.*

The CHAIRMAN moved the adoption of the report, and, after referring to the unavoidable absence of Sir Richard Webster in Paris, said he thought that the work done during the Session was very much to the credit of the Society. It covered a variety of subjects, all of them being of an important and useful character. The present report, he thought, would bear comparison with any reports of former years.

Sir EDWARD BIRKBECK seconded the motion.

Mr. THOMAS HILTON suggested, for the consideration of the Council, whether some steps could be taken to obtain a larger revenue from the advertisements published in the Society's *Journal.*

Mr. W. MARTIN WOOD expressed his pleasure at learning from the report that the ordinary work of the Society had in no way suffered by the organisation of the British Section of the Chicago Exhibition. That fact, he thought, showed that the Society would be justified in undertaking additional work in the future.

Mr. HYDE CLARKE said that the *Journal* of the Society was a valuable publication, but he did not see it on the railway bookstalls or in booksellers' shops. He thought it would be well to consider whether further facilities for obtaining copies should not be afforded to the general public.

Mr. WOOD suggested a modification of the rule relating to the amount of the life subscription.

The CHAIRMAN said that the matter would receive the attention of the Council.

The ballot having remained open for one hour, and the Scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Edinburgh, K.G.
Sir Frederick Abel, Bart., K.C.B., D.C.L., D.Sc., F.R.S.
Duke of Abercorn, K.G., C.B.
Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.
Sir Edward Birkbeck, Bart.
Sir Frederick Bramwell, Bart., D.C.L., F.R.S.
Michael Carteighe
Professor James Dewar, M.A., F.R.S.
Major-General Sir John F. D. Donnelly, K.C B
Sir Henry Doulton
Sir Douglas Galton, K.C.B., D.C.L., F.R.S.
Lord Kelvin, P.R.S.
C. Malcolm Kennedy, C.B.
Sir Frederick Leighton, Bart., P.R.A.
Sir Villiers Lister, K.C.M.G.
The Lord Mayor
J. Biddulph Martin
General the Right Hon. Sir Henry F. Ponsonby, G.C.B.
William Henry Preece, F.R.S.
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The report having been unanimously adopted,

The CHAIRMAN said that the thanks of the Council and the members were due to the staff, both here and in Chicago, for the able and conscientious way in which they had performed their duties. That, in view of the large amount of extra work entailed, could only be done by the most unflagging industry. They had heard from Sir Henry Wood at Chicago as to the admirable work done out there, and he thought the meeting would agree with him in passing a vote of thanks to Sir Henry Wood, Mr. Wheatley, and the whole of the staff of the Society.

Sir EDWARD BIRKBECK, who had lately returned from Chicago, was glad, from his personal experience of the vast amount of work done by Sir Henry Wood and his assistants, to endorse everything the Chairman had said.

The vote was carried unanimously.

On the motion of the CHAIRMAN, a vote of thanks was passed to the scrutineers.

Sir DOUGLAS GALTON proposed a vote of thanks to the Chairman, on whom, he said, a great deal of extra responsibility had devolved in consequence of Sir Richard Webster's enforced absence for some months.

The resolution was seconded by Sir SAUL SAMUEL, and carried.

The CHAIRMAN responded, and the meeting was then adjourned.

CANTOR LECTURES.

MOSAIC: ITS HISTORY AND PRACTICE.

By C. HARRISON TOWNSEND, F.R.I.B.A.

Lecture I.—Delivered May 8, 1893.

(Continued from page 756)

It is to the 12th century that we owe the superb mosaics of Torcello and St. Mark's, Venice. The west wall of the cathedral of the former island is covered with the subject usually reserved for that portion of a church. In six bands, and altogether containing no less than 150 figures, are represented the Judgment-hall and Paradise, with the Resurrection in the upper portion, where Christ is represented breaking through His tomb. The Virgin over the door is on a gold ground, and is robed in gold, the folds of drapery being blue shades and black lines. The angels on the right, in the second band, are a charming piece of colour; they, and the flames of hell, are treated in the softest tones of dull red or terra-cotta. Evidently intended as a contrast to this crowded and dramatic series, one sees, on turning to the Eastern apse, the whole space occupied by a solemn and solitary figure of the Virgin Mary. The two treatments offer to the mosaist a lesson, marked in its distinctness, as to the immeasurable superiority of the simple in design as compared with the complicated.

The isle of Torcello, then crowded, busy, and rich, was in direct rivalry with Venice. So we might expect to find, as we do, that more or less in competition with the beautifying of the church on the smaller island, the Venetians were industriously at work on their beloved St. Mark's. And, as might also be looked for, the mosaics then executed bear strong traces of the Greek manner.

The history of St. Mark was carried out in the Chapel of St. Zeno; our Lord, the Virgin, David, Solomon, and the prophets on the dome of the choir; the four rivers of Paradise and the four Evangelists in the spandrels of the central dome; the Almighty surrounded by saints in the apse; the Holy Ghost and the nations to whom the Gospel came in the western dome; Saint Clement in the chapel of that name, and above the door here, mosaics (signed Petrus, and dated 1159) representing the history of Cain and Abel.

During this great renascence of the mosaic art, the highly important work in Sicily—at the cathedrals of Monreale and Palermo, the Palatine Chapel, and the Martonara—were undertaken. At Monreale the church was, as Fergusson says, evidently so designed that all other features might be subordinated to this colour treatment. Lucius III., in 1182, declares that "its like hath not been constructed by any king even from ancient times," and the late J. A. Symonds says it is without equal in "the gorgeousness of a thousand decorative elements subservient to one controlling thought........The semi-dome of the eastern apse above the high altar is entirely filled with a gigantic half-length figure of Christ. His face is solemn and severe, rather than mild or piteous........Below him, on a smaller scale, are ranged the archangels and the mother of the Lord, who holds the child upon her knees. Thus Christ appears twice on this wall, once as the Omnipotent wisdom, the Word by whom all things were made, and once as God deigning to assume a shape of flesh and dwell with men." The rest of the walls are covered with subjects comprising pretty nearly the whole of the incidents of both the Old and New Testaments.

The illustration I give (Fig. 7, p. 773) is interesting as presenting one of the very earliest representations in mosaic of the Crucifixion.

King William, the donor, offering his church to the Virgin, are shown on the next photograph.

The lower portions of the walls are covered with costly marbles, inlaid with a countless variety of design in Cosmati mosaic. The Arab element, so noticeable in Sicilian work,

s very evident in the form of the upper part of hese panels.

I have just alluded to "Cosmati" mosaic, and may here explain the word briefly, by saying that the Cosmati were a family who for two or three generations were celebrated as mosaists in Rome. Their name has been attached to a particular form of pattern work generally let into a marble bed. We have very beautiful examples of this method in the cloisters of St. John Lateran, Rome, and I further illustrate it by a piece of a shaft from St. Mark's, Venice, lent me by South Kensington Museum, and by a photograph of the pulpit of St. Cesareo, Rome.

In the Martonara or Chapel of the Admiral, the portraits of George of Antioch and of King Roger are the only ones now remaining. The Palatine chapel is very richly decorated, and is an altogether lovely interior with its finely

Fig. 7.

Cathedral Monreale.

inlaid pavement, glistening white marble dado inlaid with pattern work in mosaic, and the series of Old and New Testament subjects—a veritable "Biblia Pauperum" or poor man's Bible—that cover its walls.

In the Holy Land the church of the Holy Sepulchre is mentioned by M. Gerspach as possessing fragments, at all events, of 12th century mosaics. But these I have not seen, and Ciampini's drawings of them give little information precise enough to go upon.

During this period it was that the Eastern Church showed a short-lasting energy in restoring and renewing its mosaic pictures, the Convents of Mount Athos being particularly active in the revival. I understand that Mr. R. W. Schultz has in hand a volume (to the appearance of which all mosaic-lovers are looking forward) treating at length of some of the all-but-unknown works of the Greek artists of this period.

The 13th century is one of high importance

for the consideration of our object. Florence, on whom the light of its glorious day of art was beginning to throw its dawn-beams, chose for the decoration of its famous baptistery the subject of the Last Judgment. For myself, I do not think the composition, nor, indeed, the colouring, very happy, with the exception of the highly impressive figure of our Lord.

Vasari keeps for us the record here, as in Venice, of the employment of Greeks in the work, and tells us how Andrea Tafi, overweighted by his difficulties, employed a Greek—one Apollonius—to assist and advise as to the *technique*, and further enlisted the help of Gaddo Gaddi. To the latter are due the prophets below the windows. The whole work was restored only some 50 years later.

The mosaic at San Miniato is restored out of all knowledge.

To Cimabue is often attributed the apse of Pisa Cathedral, but there seems little evidence to connect him with this particular work, though he undoubtedly was concerned in some of the mosaics in that church.

Of the two great mosaists of the 13th century, the one Torriti, the other Torrita, the work of the former—at St. John Lateran, Rome, for instance—is far superior to his Florentine all-but namesake. Undertaken to the order of the mosaic-loving Pope Nicholas

Fig. 8.

St. Mark's, Venice.

IV., this mosaic in the apse is a very sumptuous design, of which I give an illustration. The figures, on the left, are the Virgin, St. Peter and St. Paul, and St. Francis of Assissi; on the right, St. John Baptist, St. Anthony, St. John the Evangelist, and St. Andrew. Below and between the windows are the other nine Apostles. In the groups on the extreme right and left, the two small figures are Torriti himself, and Brother James, of Camerino, his fellow-worker on this beautiful picture.

I give a detail of the head of our Lord, as to which Fontana tells the legend that it miraculously appeared to Constantine, on the occasion of the solemn consecration of the church. But the character of the work refutes this pretty story. The stags near the central cross are reminiscences on the mosaist's part of those in the apse of St. Clement's, Rome, a work, probably, of the early 12th century, though by some dated 100 years later.

The great name of Giotto is, or, rather, was connected with the celebrated Navicella, or Ship of the Church, originally in Old St. Peter's at Rome. But seeing that it was, in the 17th century, twice bodily removed—in 1617 and in 1639, and again by Pope Urban VIII. and Innocent X., and finally "restored by Clement X. of blessed memory," as the

old Italian chronicler puts it, I am justified in regarding it as what was rather than what is the work of the great Florentine.

At St. Mark's, Venice, the beautiful series above the doors of the west front are of this —the 13th century. Only one of them (Fig. 8), alas, remains, and of the others replaced by inferior and debased works, principally in the 17th and our own century, we have left us as a record only their careful representation by Carpaccio in one of the St. Ursula series in the Accademia.

This very beautiful lunette, as I saw but a month ago, is in the hands of the restorer. And my experience of modern mosaic restoration makes me feel absolutely and grievously sure that it will come out of that operation new, smart, gaudy, smooth, and—spoilt.

A late 13th and early 14th century work is the important mosaic (again by Torriti) in the apse of Sta. Maria Maggiore, Rome. It represents the crowning of the Virgin. The small figures are Pope Nicholas IV. (the donor) and Cardinal Giacomo Colonna, the saints behind them being St. Peter, St. Paul, St. Francis of Assisi, and St. Anthony, and the two St. Johns. Another panel I show illustrates the legend of the dreams of Pope

Fig. 9.

St. Mark's, Venice.

Liberius and John the Patrician that instructed them as to the building of the church. This work is, we are told by Vasari, from the hands of Gaddo Gaddi.

In St. Maria, in Trastevere, after the lapse of four centuries further works were now undertaken, the artist being Pietro Cavallini. Of the series of scenes from the life of the Virgin, I give the panel representing her birth. It is interesting to note how closely Cavallini, a pupil of Giotto's, worked on the lines and principles of his great master. This really is a fresco translated into mosaic, and it is one of our early premonitions of the fate about to fall upon the mosaist's art.

At St. Mark's, Venice, the chapel of St. Isidore was decorated.

In the following, the 15th century, as we approach the full Renaissance period, we find associated with the art of mosaic the names of artists with which we are very familiar. In Florence, Domenico Ghirlandaio undertook, amongst other work, the Annunciation over the north door of the Cathedral. Baldovinetti carried out the head of Christ above one of the doors in the baptistery. It is to this century that we owe some of the most striking and beautiful mosaics in St. Mark's. In the Capella dei Mascoli (Fig. 9) the life of the Virgin was represented by a series which

Michele Giambono designed, executed, and signed. So far you will see that though the coming Renaissance is not without its influence on the draperies, for instance, yet the true feeling for mosaic design is shown in the highly conventionalised treatment of the architectural background.

The 16th century is the extreme and ultimate point to which I shall think it worth while to conduct you. For already towards the end of the preceding one the signs of decadence are plainly visible in the work of the mosaist. The fatal heresy that his art might meet that of the painter on the same ground, and enter into competition with him and his methods and aims, grew and spread, and ended by leaving mosaic a *tour de force* of *technique*, and a vulgar imitation of another form of

Fig. 10.

Sta. Maria del Popolo, Rome.

art. Even Vasari, in writing of the Zuccati brothers, thinks his highest praise may take the shape of describing their work as being so like oil paintings, that it was impossible to detect the difference from a little distance. A similar false criticism appeared the other day in a London newspaper. This criticism came from Venice, of all places from which to date such a judgment!

The great name of Raphael is associated with the mosaics in the Chigi Chapel, in Sta. Maria del Popolo, Rome. These further emphasise the other error that was eating the vitality out of mosaic, the divorce of the designer and the executant; for now a large class of mosaic copyists, rather than artists, had sprung up; and it was to one of these—Luigi di Pace—that Raphael committed his series representing the "Creation of the Heavenly Bodies."

I show on the walls (by Mr. Purdon Clarke's kindness) a very faithful paper impress of his series ("Venus and the Sign Libra") Fig. 10), and, by a slide, a portion of the same subject to a larger scale. The detail of the cupid shows us the monogram of the worker Di Pace. I shall refer to this work again in my second lecture.

At St. Mark's, such artists as Tintoretto and Titian were, in the meantime, designing and directing works carried out by the Bianchini, Zuccati, and others. Venice, now at the height of her greatness and wealth, spared nothing to her beloved church. The list of her 16th century mosaic is too long to give in full. Let us, however, signalise the panel of St. Mark's (in the *atrium* over the central door), designed by Titian. It shows how far we have travelled from the simple and direct manner of the 11th century work adjoining it; and to me it seems to present nearly all the features that a mosaic should not possess. The Zuccati Brothers carried out the huge panoramic and sensational subjects on the soffit of the westernmost arch. This work, which represents Apocalyptic scenes, was the cause of a curious dispute. The two workers were accused by their fellow-craftsmen and rivals—the Bianchini and others—of making use of the paint brush to obtain their effect. The Venetian Senate, indignant, and anxious to learn the truth, immediately appointed perhaps the very strongest commission of artists that has ever been, consisting of Titian, Veronese, Tintoretto, Il Schiavone, and one other. In the result, the painters reported that the paint-pot and brush had indeed been freely employed, but that the offence was not great, for the colour of the enamel mosaic underneath the paint was fully as fine. However, the Senate, thinking they had paid for mosaic, and ought to have mosaic, ordered the Zuccati to execute afresh the incriminated parts, and to do it at their own cost.

Finally, in reference to Titian, it was by his advice that the disastrous work—even then called "restoration" only—was undertaken in the next century. And by this time the mosaist was an altogether degraded and despicable workman. Any vitality still remaining in his art could not indeed survive the introduction by Muziano di Brescia, about 1580, of a mastic or oil, instead of a lime, cement as the bed for mosaics. The slow-setting properties of the new material allowed to the executant opportunity for deliberation and alteration that destroyed all directness and simple naïve impressionism. As my final illustration, I give an example which I regard as a compendium of what to avoid in a mosaic, whether we consider composition, colour, or methods of *technique*. It is the tympanum over the central doorway of St. Mark's, and its date is 1836.

In my next lecture I shall treat of those three attributes — composition, colour, and methods—and, I think, we shall find that we could not have hoped to consider them to any profit to our mosaic work of to-day without some such systematic and chronological survey of the legacies of the past as you have been patient enough to listen to to-night.

ILLUSTRATIONS REFERRED TO IN PRECEDING LECTURE.

CENTURY.	SOURCE OR PLACE OF MOSAIC.	SUBJECT.
	Siena Cathedral	"Impasto" floor pavement — Death of Absalom.
	Pompeii	Fountain recess.
	In the Museum at Naples	Battle of Arbela—Death of Darius.
	Do. Do.	Do. —Detail head of soldier.
	Do. Rome	"Pliny's doves."
IV.	Sta. Costanza, Rome: vault of ambulatory	The culture of the vine.
,,	Do. Do.	Design of guilloches.
,,	Sta. Pudenziana, Rome: apse	Christ in glory.
V.	St. Paul extra Muros, Rome: triumphal arch	Head of angel.
,,	Sta. Maggiore, Rome: triumphal arch	New Testament subjects.
,,	Archbishop's Chapel, Ravenna	Figure of the Virgin.
,,	Tomb of Galla Placidia, Ravenna	The Good Shepherd.
,,	Do. Do.	Two saints, vase and doves between.
,,	Baptistery of the Orthodox (S. Giov. in Fonte) Ravenna.	Baptism of Christ.
,,	Baptistery of the Orthodox (S. Giov. in Fonte) Ravenna.	Two Apostles.

ILLUSTRATIONS REFERRED TO.—(*Continued.*)

CENTURY.	SOURCE OR PLACE OF MOSAIC.	SUBJECT.
VI.	Baptistery of the Arians (Sta. Maria in Cosmedin) Ravenna	Baptism of Christ.
,,	S. Apollinare Nuovo, Ravenna; N. wall	Virgins bearing crowns.
,,	Do. Do. S. wall	Christ and angels.
,,	Do. in Classe, Do. Apse	Christ and His sheep.
,,	Do Do. S. side of Chancel	Melchisedek feasting.
,,	S. Vitale, Ravenna; Apse	Christ on globe.
,,	Do. Do.	Court of Justinian.
,,	Do. Do.	Do. Theodora.
,,	Do. Do.	Head of Justinian.
,,	Do. Do.	Do. Theodora.
,,	S. Lorenzo fuori le Mura, Rome; Tribune	Christ enthroned.
,,	SS. Cosmo and Damian, Rome	Triumphal arch and apse.
,,	Do.	Saints.
,,	Sta. Sofia, Constantinople; Elevational view of Bema	Marble and Mosaic treatment.
,,	Sta. Sofia, Constantinople; Narthex	Christ in glory (in Narthex).
,,	Do. Do.	Sts. Gregory. Dionysius, Nicholas, and Gregory the Armenian.
IX.	Sta. Prassede, Rome	Sts. Paul, Pudenziana, and Zeno.
X. & XI.	St. Mark's, Venice; Baptistery	St. Athanasius.
,,	Do. Do.	Looking south.
,,	Do. Do.	Noah's Ark.
,,	Do. Do.	Floor paving.
XII.	Sta. Francesca Romana, Rome: Apse	Christ and four saints.
,,	Torcello Cathedral, west wall	Last Judgment—upper part.
,,	Do. Do.	Do. —lower part.
,,	Cathedral, Monreale Do.	General view.
,,	Do. Do.	Bible subjects on walls.
,,	Do. Do.	Do. Do.
,,	Do. Do.	King William offering Ch: to the Virgin.
,,	Do. Do.	Marble and mosaic treatment of walls.
,,	S. Cesareo, Rome	Do. Do. of pulpit
XIII.	St. John Lateran, Rome; Apse	Adoration of the Cross.
,,	Do. Do.	Head of Christ.
,,	St. Mark's, Venice; N.W. door of west front	The Church of St. Mark.
XIV.	Sta. Maria Maggiore, Rome; Apse	The crowning of the Virgin.
,,	Do. Do. Do.	Dream of Pope Liberius.
,,	Sta. Maria in Trastevere, Rome	The birth of the Virgin.
XV.	Cathedral, Florence; N. door	The Annunciation.
,,	St. Mark's, Venice; chapel dei Mascoli	The life of the Virgin.
,,	Do. Do. Do.	Do. Do.
XVI.	Chigi Chapel in Sta. Maria del Popolo, Rome	Venus and the sign Libra.
,,	Do. Do. Do.	Cupid from same.
,,	St. Mark's, Venice; centre door	St. Mark.
XIX	Do. centre arch	Last Judgment.

Miscellaneous.

REPORT OF THE ASTRONOMER ROYAL.

The report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, was read at the annual visitation, on June 3. It is mentioned that the sun, moon, planets, and fundamental stars have been regularly observed on the meridian as usual. The extraordinarily fine weather in the months of March and April made the number of observations much larger than ever before. As an illustration of the continuity of fine weather in the two months referred to, it is stated that 2,600 transits and 2,300 circle observations were made, the average corresponding numbers for the seven previous years being 945 and 877 respectively; that 70 observations of Polaris, or Polaris S.P. were obtained (exclusive of isolated observations which are only used for

azimuth error, and not for place of the star), the average for these months in 10 years preceding being 22·2, and the greatest in any of these years 38 (in 1885); and that 24 groups of clock stars, extending over more than 12 hours were obtained, the mean for 10 years preceding, in March and April, being 2·6. In this last case something must be attributed to the special interest shown by the observers recently in obtaining long groups of clock stars.

With the astrographic equatorial 722 plates, with a total of 1,812 exposures, have been taken on 161 nights in the year ending May 10, and of these 116 have been rejected, viz.:—57 from photographic defects, 6 from mechanical injury, 12 from mistakes in setting, 6 from the plate being wrongly placed in the carrier, 7 from failure in clock driving, and 28 from interference by cloud.

Some experimental plates of Jupiter, Saturn, double stars and lunar craters, have also been taken with the image enlarged about 14 times by a secondary magnifier, consisting of a triple cemented concave lens of $1\frac{3}{8}$ inch diameter and 3 inch focus, supplied by Mr. T. R. Dallmeyer. The results are very promising.

Under the heading "Meteorological Observations," the Astronomer Royal writes:—

The mean temperature of the year 1892 was 48°·1, being 1°·4 below the average of the 50 years, 1841-1890. The highest air temperature in the shade was 85°·9, on June 10, and the lowest 17°·6, on December 27. The mean monthly temperature in 1892 was below the average in all months excepting May, August, and November. In March it was below the average by 4·°4, in October by 4·°6, and in December by 3·°0.

The mean daily motion of the air in 1892 was 265 miles, being 17 miles below the average of the preceding 25 years. The greatest daily motion was 687 miles, on January 29: and the least 48 miles, on December 28. The greatest pressure registered was 11·8 lbs. on the square foot, on October 9.

During the year 1892, Osler's anemometer showed an excess of about 20 revolutions of the vane in the positive direction N., E., S., W., N., excluding the turnings which are evidently accidental.

The number of hours of bright sunshine recorded during 1892 by the Campbell-Stokes sunshine instrument was 1,277, which is about 7 hours below the average of the preceding 15 years, after making allowance for the small difference of the indications with the Campbell and Campbell-Stokes instruments. The aggregate number of hours during which the sun was above the horizon was 4,465, so that the mean proportion of sunshine for the year was 0·286, constant sunshine being represented by 1.

The rainfall, in 1892, was 22·3 inches, being 2·2 below the average of the 50 years 1841-1890.

With regard to the recent drought, the following particulars may be of interest:—The sunshine registered in the months of March and April has been phenomenal. For March it was 155 hrs. 1 min. and for April 231 hours; the greatest numbers for these months, in the 16 years 1877-1892, being 141 hours (1880, March), and 196 hrs. 3 min. (1892, April). The greatest values for any month in the 16 years preceding are 277 hrs. 1 min. (1887, July), 267 hrs. 1 min. (1877, June), and 237 hrs. 8 min. (1882, May); and, if we consider the ratios of sunshine to the total time the sun was above horizon, or to the total time, less $1\frac{1}{2}$ hours each day, during which the sun is too low to give a record on the paper, we find that April, 1893, was the sunniest month yet recorded.

	Ratio to Total No. of Hours.	Ratio to Total, less $1\frac{1}{2}$ hours daily.
1877, June....	0·540....	0·594
1882, May....	0·493....	0·546
1887, July	0·558....	0·615
1893, April ..	0·557....	0·624

The mean amount of cloud registered in March, 1893, was 4·0, and in April 3·1, on the usual scale. According to the table for Greenwich for 70 years (given by Mr. Ellis in the "Quarterly Journal" of the Royal Meteorological Society, vol. XIV., p. 187), the least previous value for March since 1818 was 5·0 (in 1841), and for April, 3·7 (in 1840). The least mean value in any month since 1818 is 3·0 (in 1848, May), and the next is 3·2 (in 1865, September). The least pair of mean values for any two consecutive months is 3·3 and 4·7 (1835, July and August), and for March and April is 6·2 and 3·7 (in 1840). It will thus be seen that the amount of cloud recorded for last March and April is considerably less than that for any two consecutive months previously.

For the 72 days from 1893, March 5 to May 15, the total amount of rain measured was only 0·246 inches, the average for the corresponding period being about 4 inches. There was a period of 30 days, from March 18 to April 16, without rain. There is no similar dry period of 72 days since the commencement of the register in 1841. It is worthy of note that immediately preceding the drought there was heavy rain; between (1893) February 1 and March 4 rain fell on 25 days, to the total amount of 3·03 inches, the average rainfall for the corresponding period being about 1·67 inches.

During the period of nine days, 1893, April 18 to 26, the maximum temperature on 8 days was above 70°, including April 20, when the maximum was 80°. For the 50 years, 1841-1890, the earliest recorded occasion in any year on which the thermometer rose to 80° was April 27, in 1865, when it rose to 81·5°. The mean maximum temperature of the 9 days was 74·1°, being 15·0° above the average for the corresponding days for 50 years. The mean temperature of the 9 days was 58·5, or 10·1 above the 50 years' average. From April 21 to 26, the total sunshine registered was 71 hrs., a daily average of 11 hrs. 8 min.; the daily value being 11 hrs. 5 min., and the greatest 12 hrs. 6 min., a run of exceptional

uniformity. The daily number of hours the sun was above the horizon, at a sufficient altitude to register, was 12 hrs. 8 min.

The report concludes with the following general remarks:—"The work of the Observatory during the past year has been carried on under circumstances of exceptional difficulty. In the first place, the operations for the determination of the longitudes of Paris and Montreal involved the absence of the chief assistant and of another assistant for protracted periods during last summer and autumn. Secondly, for six months the Observatory was left entirely without the services of a clerk, and the appointment of a permanent officer to undertake cash and other clerical duties has not yet been made. These duties, which have greatly increased of late years, have thus been thrown on the Astronomer Royal and his staff, and the scientific work of the Observatory has suffered in consequence. It has been necessary for me to make strong representations to the Admiralty on this subject, and I have hopes that a satisfactory definitive arrangement will not be much longer deferred. Further, the delay in providing necessary accommodation for the staff has greatly hampered the work, and much time and thought have been required to improvise temporary office rooms contingent on the season of the year. Under these circumstances it is due to the zeal and energy of the assistants and computers that the output of work for the past year is so good, and that, except in regard to the printing, arrears have not been suffered to accumulate. But it has not been possible for me, while harassed with constant interruptions on matters of administrative detail, to carry out the scientific investigations connected with the Observatory, which properly fall within the province of the Astronomer Royal. Thus, during the past year, I have had repeatedly to lay aside the important subject of the measurement of the plates of the astrographic chart, in order to deal with details of cash accounts, and other similar matters, which properly pertain to the functions of a clerk. In this connection I may mention that, some years ago, I proposed a photographic corrector, which, at a comparatively small cost, would render an ordinary astronomical refracting telescope available for photography; but, though a trial instrument has been made, and though I have partly worked out the details of a more complete form, I have never been able to command sufficient leisure, tolerably free from interruptions, to enable me to complete the rather troublesome optical calculations. Such a corrector could be usefully applied to the 28-inch telescope, as well as to other large instruments; but, under present conditions, I fear that there is little prospect of my being in a position to work out the idea.

The growth of the Observatory buildings, involving the introduction of masses of iron, raises the question of the possible disturbing magnets in their present position. Though the masses of iron would be at such a distance that they could not sensibly affect the registers of magnetic changes, which are purely differential, it is possible that the aggregate effect on the absolute determinations of the magnetic elements might become appreciable. Under these circumstances, it is desirable that an auxiliary magnetic station, for determination of absolute values of the magnetic elements, should be established in the mmediate neighbourhood of the Observatory, at such a distance that there would be no suspicion of disturbance from the iron in the buildings.

Obituary.

Sir W. Mackinnon.—Sir William Mackinnon, whose death, in his seventieth year, occurred on the 22nd inst., was an admirable type of those merchant princes whose sagacity and enterprise have contributed so largely to the growth of the British Empire. One of the most powerful corporations in the world, the British India Steam Navigation Company, which now possesses a fleet of about 110 vessels, with an aggregate tonnage of 270,000 tons, owes its origin to his business capacity, but his name will go down to posterity as the founder of the British East Africa Company. It is, perhaps, not too much to say that but for him there would have been no Emin Relief Expedition. Like so many successful Scotchmen, he was the architect of his own fortunes, and numbers of his countrymen who now occupy high positions in the commercial world in various parts of her Majesty's dominions received their start in life from Sir William Mackinnon. He was as philanthropic as he was public-spirited, and many charities in England, as well as in Scotland, will miss his liberal support. Sir William became a Companion of the Order of the Indian Empire in 1882, and the honour of a baronetcy was conferred upon him in 1889. He had been a life member of the Society since 1884.

Sir T. Shepstone.—The death is announced, from Durban, of Sir Theophilus Shepstone, K.C.M.G., whose name for nearly sixty years has been familiar to English ears in connection with South African affairs. He was born in 1817, and, when only eighteen, received his first appointment at the Cape as headquarters interpreter of the Kaffir language. On two occasions he made valuable contributions to the Society—his first paper, read during the session of 1874, being entitled "Remarks on the Geographical and Physical Character of the Diamond Fields of South Africa." The second dealt with the early history of the Zulu-Kaffir race of South-Eastern Africa, and obtained the Society's Medal in 1875. His public services secured for him a Companionship of the Order of St. Michael and St. George in 1869, and a Knight Commandership in 1876.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

CONVERSAZIONE.

The Society's annual *Conversazione* took place at the Imperial Institute, South Kensington, on Friday last, June 30, and was attended by a large number of visitors.

The principal galleries of the Imperial Institute were open, including those containing the collections illustrating the natural resources of the Colonies and India, Indian art metal work, &c. A collection of rough South African diamonds, and the largest pair of diamonds in the world cut from a single stone (the former kindly lent by Messrs. Whernan, Beit, and Co., and the latter by Mr. J. Mylchreest), were exhibited in the Cape Colony Court.

The reception was held in the vestibule by Sir Frederick Bramwell, Bart., D.C.L , F.R.S., Deputy-Chairman, and the following Vice-Presidents and Members of Council:—Sir Frederick Abel, Bart., K.C.B., D.C.L., F.R.S.; William Anderson, D.C.L., F.R.S.; Sir George Hayter Chubb; Francis Cobb; Major-General Sir John Donnelly, K.C.B.; Sir Henry Doulton; Francis Elgar, LL.D; C. Malcolm Kennedy, C.B.; Sir Villiers Lister, K.C.M.G.; J. Biddulph Martin; John O'Connor; and Sir Owen Roberts, M.A., D.C.L.

The Red Hungarian Band (conductor, Mr. M. Poole) performed in the vestibule, and promenade concerts were given by the Band of the Royal Artillery (conductor, Cavaliere L. Zavertal) in the Indian Pavilion, and by the Band of H.M. Scots Guards (conductor, Mr. Edward Holland) in the West Gardens. The programme of music was as follows:—

RED HUNGARIAN BAND.

1. March... ... "Wiener Schwalben" ... Schlogel.
2. Overture ... ... "Mireille" ... ... Gounod.
3. Valse ... "Mondnacht auf der Alster" Fetras.
4. Czardas ... ... "Hungarian" ... ... Keler Bela.
5. Entr'acte ... "Grusse an Warschau" ... Bilse.
6. Intermezzo... "Forget-me-not" ... Macbeth.
7. Valse ... ... "Märchen aus dem Orient" Strauss.
8. Czardas ... ... "Pustak Fia" ... Keler Bela.
9. Spanish Serenade "La Paloma" ... Yradiere.
10. Selection ... ... "Le Caid" ... A. Thomas.
11. Tonstuck ... "Heinzellmannchen" ... Eilenberg.
12. Valse ... ... "Faschingskinder" ... Ziehrer.
13. Czardas ... ... "Hungarian" ... Michiels.
14. Galop ... ... "La Chasse au Lion" ... Kolling.

BAND OF THE ROYAL ARTILLERY

1. March "Aller Ehren ist Oesterreich Voll" Nowotny.
2. Overture ... "Dichter und Bauer"... ... Suppé.
3. Valse ... ... "Carlotta" ... ... Millöcker.
4. Selection ... ... "Shamrock" ... ... L. Zavertal.
5. Intermezzo ... "Loin du Bal" ... ... Gillet.
6. Song ... ... "Der letzte Gruss" ... ... Komzak.
7. ... ..."Wiener Mad'ln" ... ... Ziehrer.
8. Three Dances from "Henry VIII." ... ... German.
9. Intermezzo "Cavalleria Rusticana" ... Mascagni.
10. Serenade... ... ... Schubert.
11. Ungarische Tänze ... ... Brahms.
12. Selection... ... "Tannhäuser" ... ... Wagner.

BAND OF H.M. SCOTS GUARDS.

1. March ... ... "Hochland-Klänge"... ... Millöcker.
2. Overture ... "Le Domino Noir" ... ... Auber.
3. Grand Selection "The Flying Dutchman"... Wagner.
4. Walzer ... ... "Orient-Rosen" ... ... Ivanovici.
5. Spanisches Standchen ... ... Eilenberg.
   Cornet Solo, Corporal W. Drake.
6. Gavotte "Wonnetraum" (The Dawn of Love) Sabathil.
7. Ballet Music ... ... "Faust" ... ... Gounod.
8. Les Rameaux ... ... Faure.
9. Mazurka Hongroise (New) "La Tzigane" Ganne.
10. Variations on a German Volkslied ... Siegfried Ochs.
   (In the styles of Celebrated Composers.)

Synopsis:—The humour of this piece consists in the rendering of the variations, on one of the simplest old German airs, in such a manner that the style for which each great composer is celebrated is reproduced in a quaint parody within the limits of a few bars. A short description of the leading idea may be acceptable.

Thema.—Old song "Kommt ein Vogel geflogen."—Variations in the style of—(1) J. S. Bach—Varying the simple air with learned counterpoint, closing it like an organ fugue. (2) Haydn—A string quartet. (3) Mozart—A clarionet solo. (4) Joh. Strauss—A valse. (5) Verdi—An "aria di bravura," in the operatic style, with the oft-repeated finale of Italian dramatic music. (6) Gounod—Parody on the Garden Scene in "Faust." (7) Wagner—Parody on two motives from "Lohengrin" and "Tannhäuser." (8) Beethoven—A violin sonata (for three instruments). (9) Mendelssohn—Imitation of the intermezzo in "Midsummer Night's Dream." (10) Brahms—Parody on "Hungarian Dances." (11) Meyerbeer—Here the air is treated in the grand heroic style; after an introduction by the drums, the grand scene, "The Blessing of the Daggers," in the "Huguenots," is parodied. (12) A military march.

11. March ... ... "Lorraine" (New) ... ... Ganne.
12. Overture... ... .. "Macbeth" ... ... Hatton.
13. Selection ... "Tannhäuser" ... ... Wagner.
14. Polka ... ..."Lilliputian" ... ... Brewer.
   Piccolo Solo, Corporal M. A. Brewer.
15. Selection ... ... "Falka" ... ... Chassaigne.
16. Grand Selection "Cavalleria Rusticana"... Mascagni.

Introduction and Chorus; Alfio's song; Scene and Prayer; Romance, "Der Santuzza;" Duet, "Sant u Turiddu;" Lola's song; Siciliana; Intermezzo; Song, "Drinking Song;" Turiddu's Farewell to his Mother; and Finale Grandioso.

God Save the Queen.

CANTOR LECTURES.

MOSAIC: ITS HISTORY AND PRACTICE.

By C. Harrison Townsend, F.R.I.B.A.

Lecture II.—Delivered May* 15, 1893.

In my first lecture I dealt, as fully as the time at my disposal allowed, with the history of pictorial mosaics.

Rapid though my sketch was forced to be, it had, I hope, the result of impressing you with its supreme importance. And I trust we recognise it, after that review, as one of the most interesting and important chapters in the world's art.

We saw, in our hasty retrospect, the art of mosaic rise from the simple pebble-work of primitive man to its culmination in the gorgeous pictures of Venice, Florence, and Ravenna, when Botticelli and Raphael were proud to engage in so noble an art, and Ghirlandaio, in a passion of enthusiasm, declared "the true and only painting for eternity is mosaic."

We watched it, as I say, brighten from its early dawn to a meridian of splendour and of grandeur. Then, alas, the noon of vigour past, we looked on at its decline till the gathering shades seemed to presage its darkness and its end.

But, as my opening words last Monday made clear, I, for my own part, think that the threatened extinction never became absolute. I hold that to-day, more clearly than at any time during the last three centuries and a half, one can discern those first faint pulses of the coming light, a light that speaks of another day at hand, when the glories of mosaic shall revive, and we shall start afresh —learners by experience, and gainers by the lessons of the past.

In reviewing the history of mosaic, I refrained of set purpose from all criticism of the examples we looked at together. It seemed to me that the most effective order in which to deal with the subject was to consider, first, the history of mosaic work, secondly, its methods, and, lastly, to try and deduce, from both these, principles and canons to guide us in our work of to-day. If to some I seem elementary in my treatment of that second division, I trust they will be patient with me.

The materials of which a picture in mosaic consists may be, as I said last Monday, either terra-cotta, marble, or opaque glass. The latter, generally known by its Italian name of smalto, is the medium in which we are most interested. It is glass, coloured throughout its entire thickness (and not only a thin film of coloured glass, as is the case with the pot-glass with which we are familiar in stained glass windows), and is cast into circular plates, some 3-16ths of an inch thick.

The colouring-base is usually of a mineral character. M. Gerspach, the late Director of the Government Mosaic Studio in France, to whose kindly-given information I shall have to refer again, gives an interesting formula for the smalto-paste. It runs thus:—Sand, 1,300; minium, 600; nitrate of potash, 60; fluate of lime, 300; carbonate of soda, 400. A further ingredient consists, when possible, of 500 parts of old cement made according to this formula.

The colouring media are the following oxides:—Manganese for violet, cobalt for blue, nickel for brown, uranium for yellow and for black, copper for green and red, chronium for green, iron for yellow and brown, platinum for grey, iridium for black, or, of course, these materials used together, in desired proportions, to obtain the necessary modifications of tint.

I show here some specimens, which Mr. Jesse Rust has lent me, which show a variety of other tones, the result of a different method. The sample piece I hold in my hand presents, you will see, as I hand it round, a metallic effect, which it is difficult to persuade one's self is not due to some metal leaf process. The specimen is specially thin, as it forms one of the plates of material used for a scheme of flat ceiling decoration being carried out for Mr. Scott-Morton, the drawing of which he gives me the opportunity of exhibiting.

I pointed out, you will remember, last Monday, the introduction—as points of emphasis in some of the old masters' work —of various materials other than smalto or glass, such as ivory or mother-of-pearl. Thus, in the head of the Virgin—an original fragment from St. Mark's, lent by South Kensington Museum, and shown by me then —the circular ornamental *tesseræ* in the head-dress and round the neck are of ivory or bone. And on the head of the Empress Theodora,

* This lecture was illustrated by examples of modern mosaic work, contributed by Messrs. Powell and Sons, T. R. Spence, Rust, Scott-Morton, and the Vitreous Mosaic Company.

from St. Vitale, Ravenna, we find circular *tesseræ* of mother of pearl. But I think the egg-shell some writers mention is a myth; I have looked carefully for it, and in vain.

As regards the very important subject of both silver and gold-faced *tesseræ*, the actual process may be simple, but it requires much care, or the result will be that, as I have seen in some modern Venetian work, the gold flakes off, and bare spots result. The process of their manufacture is as follows:—On sheets of thin glass—such as that I now show—gold-leaf, or sometimes silver, is laid. This plate is then placed on, and permanently united, by baking with another somewhat thicker piece of glass, with the result that the two fuse into a homogeneous whole, and the gold-leaf is firmly incorporated in its thickness.

It was once the fashion to think that no hand but a Venetian's possessed the cunning necessary for success in this process. This theory does not hold good on examination. A comparison between modern Italian golds, of which one sees only too much on all sides, and those used, for instance, by Messrs. Powell for Mr. W. B. Richmond's work at St. Paul's, will, in one respect at least, make good my claim (in my first lecture) for a superior grasp of *technique* on the part of our English craftsmen. Messrs. Powell's range of gold is very fine, and their practice of subjecting it to more than one baking brings about an action on the underlying leaf that produces a great variety of tone.

In the regrettable restorations at St. Mark's, Venice, the modern gold is peculiarly brassy in appearance, as well as badly laid. At Ravenna, the priest of St. Apollinare Nuovo—an enthusiastic lover of his church's mosaics—pointed out to me the other day the palpable line of demarcation where the gold of the 6th century stopped, and was replaced by the cheap and thin modern stuff which he called "oro di California."

The gold *tesseræ* used in the old examples I showed you range in shade from a full copper-red to a bright yellow glitter like brass. Flat uniformity of tint should be avoided, and the *tesseræ* of different tones should be placed pretty well at random. When forming a background they may be of a greater size than those used for figures and ornaments. An excellent study of old gold ground may be made from the large original mosaic of the Birth of the Virgin by Orcagna, in the Italian Court, South Kensington Museum. It is advisable to run a line of *tesseræ* following the contour or outline of the design; in some of the old work, as in the Atrium of St. Mark's, mentioned by me last week, two rows are used in this way. The effect of this is to "cut out" the subject from the background in a very noticeable manner.

Silver *tesseræ* are made by a similar process to that employed for the gold. In old work they are but little used, but never in large masses. Personally, I do not think their effect very striking; certainly not as occurring in the Apocalyptic subjects on the soffit of the western arch of St. Mark's, where, by contrast with the 17th century gold adjoining it, the silver has a lead-foil-like absence of sparkle and colour. The work now in hand at St. Paul's is the principal occasion on which they have made their appearance in modern work. But even here their use is for small and detached points, such as high-lights.

A beautiful but too infrequent variety of metallic *tesseræ* is obtained by passing over the gold base a coloured film of glass. If this transparent over-glaze be some such colour as, say, a pale blue or green, or a clear red, the result is a useful series of tinted golds.

The position and lighting of a gold-ground mosaic are important considerations. The most effective opportunity it has is undoubtedly given by the semi-spherical ceiling of an apse lighted by the windows—not of the apse itself, but of the church proper. Top-light is disastrous in result. The unfortunate failure of the treatment of the staircase dome at the Louvre is very much due to the fact that it is lighted by a lantern light, with the result that "the fierce light that beats upon the" dome robs it of all mystery and of those accidentals of colour that are such helps to the worker at any form of decoration.

It is one of the cardinal faults of the modern (by modern I mean post-renaissance) mosaic worker, of Italy especially, to be proud of the fact that his "scatola di degradazione" or box of *tesseræ* comprises an infinitude of shades of each colour. Nothing, for instance, can be more absurd nor more opposed to the true principles of the art than to boast, as does the Pontifical Mosaic Studio in Rome, that it has an available stock of 25,000 different tints for its artists' use! On the contrary, study of the examples shows us that their effects were produced by the artists restraining themselves to the employment of a minimum, not a maximum, range of colours. Till about the 10th century the flesh-tints were obtained by the use of at most three or four colours, and even in

the decadent times of the 16th century only about twice this number were employed. The work now in hand at St. Paul's only demands a colour-box of about 30 tints.

As regards the size of the *tesseræ* there is no absolute rule to be learnt from the old practice. My own strong advice, based on examination, is to make use of a very much larger one than is usually employed now-a-days. The faces of the figures may, however, be worked with a smaller *tesseræ*. That used by Raphael in the Chigi Library panels seems to me to be the smallest permissible. Of this series you will remember I have already said there are most accurate paper "squeezes" in South Kensington Museum.

I have now dealt with the material and nature of the *tesseræ*, and the last point I wish to touch on in connection with them is in reference to their insertion in their bed of plaster.

The golden rule, briefly put, is to avoid a smooth finish of face. When we touch on the question of the proper principles for mosaic work we shall see how wrong we should be to attempt to rival the smoothness that we have alone any reason to expect from other methods and materials. For mosaic work in its essence is a collection of tiny bits of material, each with a different face, and set in a plastic ground, and we are false to its principles if forgetting this, we ape another medium, and either, with microscopic care, set all exactly smooth and flush, or polish the whole down at the close. The mosaics done in the Pontifical Studio to-day are thus polished smooth with fine sand, and, worse still, the cement joints are coloured with tinted wax to match the enamels. But this improper finish is the great goal of "commercial" mosaic, and of nearly all the foreign work done now. It is easy to see how it came to be the method accepted as right, when we remember that the ambition of the mosaic-worker in the decadent and dead days of the art was to hold his own as against the painter in oil or fresco, and to boast of his work (as we heard Vasari do in reference to the Zuccati brothers' mosaic) that it was indistinguishable from a painting; and when we find Ciampini, the great authority, writing, in 1690, of a work that he admired—"Picturam et opus Musivum penè germana esse dixeris."

It is, of course, possible to overdo this rough setting of the cubes; I have seen modern English examples that clearly show this. To be vigorous one need not necessarily be crude. But better, perhaps, that crudity than accept as an alternative the work the modern mosaist is doing by way of "restoration" in Italy. When in Ravenna, some eight or nine years ago, I climbed the apse of St. Vitale, and got into conversation with the old man I found employed in this baleful work. With a small hand-pick he was hacking down the old mosaic, and reinstating it with a mixture of new and old material indifferently. I pointed out that the work seemed to me in excellent preservation, and asked the old workman why it was necessary it should be renewed. To which his answer was that the authorities were having it re-done as they did not consider the surface left by the 6th century mosaist "assai liscio"—smooth enough!

This church I saw again last month. And what a difference! The mosaic of Christ enthroned on the Globe was indeed smooth and flat enough, but with its roughness had also gone its subtlety of colour, and the interest and variety that used to be, when the light played upon its unequal surface, and lighted up the irregularities of its gold ground till bright gleams shone out here and there like vivid sparks amongst dying embers.

This dreadful mania for renewal—I cannot say restoration—has, within the last few years, played sad havoc in St. Mark's, Venice, only to be compared to the results of the similar lamentable epidemic at the end of the Renaissance, when the mosaics of the 10th and 13th centuries were wiped off its west front, and the *banale* and false work of the Bianchini and the Zuccati took their place. At the present moment the only truly interesting mosaic on the façade of St. Mark is hidden by scaffolding, and, as I have seen the mosaic restorer at his work in this building, I know only too well what is likely to be going on behind the hoarding. I could say much on this subject, but must take an opportunity elsewhere. I can only urge, as my advice, that those who wish to study ancient mosaics should lose no time in visiting Italy. The restorer's hand is more ruthless than that of time, and very soon there will be none that are left untampered with, and the sham-old will, before long, everywhere replace the old.

It should, above all things, be remembered that mosaic is essentially work done to be seen and appreciated from a certain distance, and the method in each case should be considered with this peculiar and varying condition in view.

The old masters in mosaic were very careful

to bear this rule in mind, and not only to vary the size of their *tesseræ* according to the position the picture was to occupy, but also to place the cubes in their cement bed in such a way as to be most effective to the spectator. Thus, Salzenburg discovered, at St. Sofia, that the artist has, with nice calculation, arranged his *tesseræ* so as to subtend at a proper angle an imaginary line drawn from the eye of one standing in a fair position for seeing his work.

Finally, in connection with the *tesseræ* let me recommend the lapidary's wheel as a means of shaping the pieces to certain forms other than the cubes resulting from the chopper used. It is little if at all used in England, but there is no reason to maintain any prejudice against it. It was constantly used by the old men, and in certain cases, where exactitude is necessary in a shaped piece—say, for instance, the eyeball of a face—the wheel is an important adjunct.

I have now considered in some detail the smalto of which the *tesseræ* are composed, as well as the latter themselves, and the principles that should obtain in fixing them. I now come to the important consideration of the bed in which they are inserted.

The cements used in antique and early times varied considerably in their composition. Vitruvius (vii. 1) gives us a clear description of mosaic making, by which it appears that the final coat or bed consisted of pounded pottery or burnt brick (*testæ*) in the proportion of 3 to 1 of lime. In this *tesseræ* were embedded, and were subsequently washed over or "grouted" with a fine fluid cement made with marble dust. The surface was then well rubbed and polished down with iron rubbers, one of which, by the way, has been found at Silchester.

Ciampini gives the composition of ancient cement (or as he terms it "gluten, Italicé *dictum, stucco*") as being 1 of slaked lime to 3 of marble dust. He says the workers used 3 parts of Tiburtine marble—"non autem alterino speciei"—to one of slaked lime mixed with linseed oil. In later times two coats were generally (though not always) laid, in which the proportion of lime varied. The following is a good formula for lime cement:—

First coat.—Pozzolana, 10½; ground brick, 4½; slaked lime, 8½; water, 1½.

Second coat.—Pozzolana, 8½; ground brick, 3; slaked lime, 10½; water, 3.

To the second coat gum adragarth was sometimes added, to retard the setting of the cement while the work was in progress, and the pozzolana (which is a tufa or substance of volcanic origin) was much more finely powdered. The defect in cement—and this is important to mark—that one most frequently notices in old work is that resulting, not from its non-retentive power, but from its defective composition preventing it from properly and permanently adhering to the wall. In St. Apollinare in Classe, Ravenna, the mosaic on the north side of the choir has bulged out, as regards a large portion, to the extent of at least an inch and a-half, leaving an air space between the cement and the wall.

In the middle of the 16th century, Muziano di Brescia's invention of a mastic cement was responsible, to a great extent, for the evil days that were to fall upon the art of mosaic. His formula was the following:—Powdered travertine, 60; slaked lime, 25; raw linseed oil, 10; boiled linseed oil, 6. The addition of the oils to this cement has the property of retarding its setting for three or four days at least.

Each modern worker affects his own composition. Portland cement is often used, as in this specimen of Mr. Spence's. Mr. Holiday's altar-piece of "The Last Supper" was, he tells me, set in ordinary putty, on a wire netting ground, fixed in an iron frame, and the whole backed with stout sheet zinc. Mr. Richmond has a formula of his own, in which wax is, I believe, one of the ingredients.

The cement joints in a mosaic should as clearly be reckoned with in making your effect as should the lead-work in a stained glass window. It ought to be an axiom that a mosaic consists of coloured cubes and the cement, and that it is false and wrong to try and suppress these joints. They should be frankly recognised, and should play their part also in the picture you are producing.

There are evident traces in some old examples of the painter's brush filled with local colour being passed over them, and this course is actually advocated and practised by some Continental authorities of to-day. But it requires little thought to show the falsity of such an attempt to avoid the conditions of the art they are working in. My own complaint against modern English workers is that they with one consent place their *tesseræ* far too close together, and that the boldness of handling, and certain subtleties of colour, due to the use of a frankly shown joint, are consequently lost from their work. Look, for instance, at the Orcagna in South Kensington Museum I have just mentioned. Some of the *tesseræ* are $\frac{5}{8}$ths to $\frac{3}{4}$ of an inch square, and their joints in places $\frac{1}{16}$th or even more in width.

Having now by us our little cubes of coloured smalto, and the cement ground ready prepared for them, the actual method of setting the former to the desired design is our last consideration. Supposing that we have before us a space of wall apse surface to be treated with mosaic subjects, there are two or three methods by which it can be so covered.

According to the first, the artist-workman, face to face with his cement surface, and having by him the cartoon from which he is to work, draws on the cement that portion of the design he is about to undertake. He then simply places in the plastic material the *tesseræ* taken as needed from the various boxes in which they lie ready to his hand. Sometimes he may use the wheel or the chopper to round or shape such portions as the work demands.

So much for the first and simplest method. The second alternative is one necessitated by conditions that make it either impossible or difficult to do the work *in situ*. The design is traced in the studio, and the tracing turned over with its traced face downwards so that the subject is reversed. Then the *tesseræ* are dipped in gum and placed, also face downwards, on the paper. After the completion of a given portion of the subject it is cut up into convenient pieces, and these are carried to the place they are to occupy, where a slight amount of pressure only is necessary to make the whole of them at one operation take their places in the cement. Then when thoroughly set, the temporary paper ground is soaked off, and the work is done.

This process, though not much more complicated than the other, is a quick one. But it is open to the obvious criticism that it is executed with the face of the work concealed from the artist. Nor can he, as in tapestry-weaving, while working at the back, inform himself, by means of a mirror, of the effect of his work, point by point. This objection, then, is quite enough to lead one to abandon the process for the last method I will mention. *Mosaico a rivoltatura* has all the advantages, and not the great disadvantage of the just-mentioned method. I can, perhaps, best describe the process by quoting from an article I wrote on the subject some time ago.

"A frame formed of slate, or of wood lined with zinc, is placed on a slight incline. It is then 'floated' with plaster to the depth of the mosaic, and on this surface the subject is drawn. The plaster is then picked out, and finely powdered *pozzolana*, somewhat damped, or some similar material, takes its place, and in this, as a bed, are placed the *tesseræ*. These are, of course, thus sufficiently held in their place to enable one to judge the effect, and, if need be, to make modifications in the work. When the subject is completely worked out, sheets of paper are strongly pasted over its surface. This paper is cut into sizes that admit of the work being easily manipulated; and over it again is glued a piece of coarse but thin canvas. When the whole is dry, the canvas is cut, and the mosaic is then turned over on its face, whence its name. The *pozzolana* is now blown off, and piece by piece the mosaic is placed on the cement or mastic previously prepared for it in its destined position. When entirely dry, the face of the work is easily stripped of its temporary paper and canvas coverings. It is not, however, considered well to execute a piece of a larger size than about 7 feet 6 inches by 6 feet wide."

So much, then, for the process of fixing a mosaic in its place. I have now treated of the glass enamel *tesseræ*, the cement in which they are set, the methods by which this is done; and I have, lastly, to refer to the centres where we find mosaic work practised to-day—at the Pontifical Studio in Rome, by the private firms of Venice, at the Imperial Studio in St. Petersburg, and that connected with the Administration des Beaux Arts, in Paris; while in England its revival in several directions at once is characteristic of our nation, being effected in no State-aided institution, but by private persons.

The St. Petersburg school had its origin in 1846, for the studio then established in Rome by the Emperor was, a few years later, removed to the Russian capital. It works entirely according to modern Roman principles, which is of itself sufficient condemnation, even to one who has had no opportunity of seeing the mosaics in the cathedral of Saint Isaac, or in the Hermitage Palace. The Pontifical manufactory is constantly at work, principally in St. Peter's. The administrators, besides boasting of their 25,000 shades of colour, as already mentioned, are addicted to polishing the face of their mosaic.

As for modern Venetian work, have we not always with us examples, full of bright colour, smooth as a sheet of glass, and always speaking the manufactory, not the artist?

The French school, domiciled in the Gobelins, has, since January (when I visited it), ceased to exist. I have an idea that a peculiarly awful mosaic, on the staircase of the Louvre, lately finished, is not altogether un-

accountable for the Government order to at once close the studio, and dismiss the pupils and workers.

In the course of the two evenings on which I have had the honour to address you, we have together followed, but with hasty tread, the course through the centuries of one of the most interesting and most noble of arts. We have seen, through the medium of photography, the examples I have been able to gather together of the legacy handed down to us from the earlier days of art—examples lacking of course, as shown by the lantern, the glow and colour that are as it were the breath of life, the soul, without which the body is but dead bones, and which indeed neither lens nor painter's hand can bring before you. Yet I judged it far better to let the monochrome of the photograph tells its own limited tale of conception, composition, and method, and to be content with that. To go further would have been little more than bathos. For what method of reproduction can give any but a false idea of a mosaic and its overhead of burnished copper shot with a thousand gleams of gold, ranging from deep sombre brown to the clear glitter of the molten metal ? Or how represent—lifted up into a firmament such as this—the Saints, with eyes that have looked through, rather than at, the passing centuries, and vested by the hand of loving artist with festal robe of pure white, of imperial purple, or the richest red or green ?

And then in my lecture of to-night we have analysed the work of our predecessors, and extracted from it some account of the methods of the workmanship, and formed an idea of the *technique* of the art. It now remains to summarise the lessons that we are taught by the great body of precedents, at some of which we glanced last week, and to bear in mind whilst doing so the practical considerations forced on us by the nature of our material and the best manner of its use.

As with religions so with any handicraft or art: it has both its dogmas and its "pious opinions," the former a vital consideration and an absolute essential, the latter varying in weight of importance according to the temperament of the individual. In what I am going to say I will try myself to draw the distinction, but as a last resort will leave you to separate the one from the other.

Of the realm of art only a portion is claimed by the mosaic worker as his field. With him imagination reigns supreme, and he holds above all things *suggestion* as his object. His is another world than nature's, and when with his tiny squares of glass he tells us of her beauty and she teaches us, through him, her lesson, his hands are guided—let no one say restricted — by the conditions of his art. Mosaic, I repeat, is an imaginative, not an imitative, not a realistic art. Its landscapes are set in an atmosphere "that never was on sea or land," its trees suggest, rather than inform us with exactness of, their species and their peculiarities of growth. It stands midway between the purely creative forms of art, in which with quickly rendered touch of brush or modelling tool the inspired artist puts into visible shape his dream, and the reproductive arts or crafts—understanding by this term those of which the design, once created, can be repeated again and again by loom or mould.

With pictorial mosaic there must be no suggestion of aerial effects nor of atmosphere. The figures must cast no shadows. Its buildings need not, indeed should not, be demonstrably inhabitable, nor even constructively possible, so long as they serve their proper function of acting as symbols, conveying as curtly as possible the idea from the artist to the spectator. I have used the word "curtly," which is more usually applied to things spoken than painted. But it serves to illustrate my position that mosaic being, like all pictorial art, a form of speech, is the one amongst all others upon which is forced the obligation of distinct and simple utterance, and of ideas condensed to their utmost limit. It must perforce—and is therein perhaps fortunate—leave to the other arts the charms of atmospheric effect, of slightly-varied shade of meaning, of mystery, of subtlety.

To this end the composition must be simple and severe, and the figures treated, as far as possible, on one plane. Crowds of persons with figure behind figure at once suggest a too pictorial and perspective method.

As Ciampini (chap. xii, tom. ii.) says, "Neque tamen judicia meo gravius peccaret, qui in operibus hisce multa ac implicata repræsenteret, quam qui figuris, vel paucis, aliisque rebus umbras apponeret."

The treatment of the flesh tints—as has been suggested by what I have said before—should be confined to the use of the fewest possible tints or shades of *tesseræ*. Finished modelling to limbs or faces, and great display of anatomical hard facts, are not to be looked for from the mosaic-worker.

The draperies should be treated flatly, and

have a value resulting rather from mass than due to an accurate or imitative representation of their folds. Their high lights may be expressed, not realistically, but, for instance, by the use of gold, to *réhausser* their red, or blue, or green, while their darker folds can be indicated by a shading, say, of red for yellow drapery, and blue for pale green.

Mosaic, as an art, is dependent on contour to tell the story in the simplest words, and, further, on local and suggestive colour, to give that story emphasis at certain points. It bears the same relation to the painters' art as bas-relief does to the figure-work of the sculptor. To borrow the terminology of the mathematician, its world is one restricted to but two dimensions, or where at least the two dimensions of height and breadth are all in all, and depth is merely suggested. For its worthy treatment it claims from the mosaist a reticence and a reserve, and a large and simple style.

And, lastly, in mosaic, above all the arts, we see the truth of the axiom of a well-known writer, "The great artist is known by what he omits." Let him then, if he would qualify for that word "great," omit all that would suggest he is borrowing from, or relying upon, the methods of another art, and all attempt to shape his work according to canons other than those of his own craft. Let him, remember, also, his great responsibility, that the work he does "is not for an age, but for all time," and that, as an old writer says of a picture in mosaic, "immortalitatem induisse videtur," or in the all-but-similar words of Ghirlandaio, "Mosaic is the true painting for eternity."

Miscellaneous.

INDIAN EMBROIDERY.

In connection with the Society for the Encouragement and Preservation of Indian Art, a loan exhibition of embroidery, executed by Indian women, is being held at Chesham-house, 142, Regent-street. The catalogue of the exhibits contains an elaborate introductory note from the pen of Sir George Birdwood, K.C.I.E., C.S.I., chairman of the Executive Committee. The curious and alluring art of painting flowers and animals on all sorts of woven stuffs ("Picturæ Textiles," Lucretius II., 35) with a needle, and threads of blue, and purple, and scarlet, and fine drawn gold and silver is, the writer points out, one of the most ancient handicrafts of the East, coeval with simple sewing, and itself originating probably in tattooing, it certainly gave origin to the richly depicted loom-wrought coverlets, hangings, and carpets, distinguished by the Greeks and Romans as tapestry.

After quoting and commenting on the references to embroidery to be found in the Scriptures and in classical writings, Sir George Birdwood proceeds :—There are no unequivocal references to embroidery in the earliest Sanskrit writings; but there can be no doubt of the art having been practised in India from the remotest date of the settlement of the country by the Vedic Aryas. India, indeed, was probably the first country that practised the art of weaving, and before it of fine needlework, and embroidery with gold and coloured threads. It is the original country of cotton; and the first silk used by mankind was probably the tussur silk of India. The muslins of India are the *sindhu* of the early Babylonian cuneiform invoices, the *sadin* of Judges xiv. 12, 13, Proverbs xxxi. 24, and Isaiah iii. 23, and the σινσών of Herodotus, words all meaning "the Indian" stuff; and the Greek word χιτών which is older than the Iliad and the Odyssey, is but the name *ktn*, given by the Sabæan Arabs and the Phœnicians to cotton, in carrying it from Western India to Egypt. The "broidered work" of Shebah, in Ezekiel xxvii. 23, 24, is thought to refer to Cashmere and similar Indian shawls, imported into Tyre through India. In a hymn in the Rig-Veda, Trita cries out in the well in which he is enclosed :—"Cares consume me, as a rat gnaws a weaver's thread." Elsewhere in the Rig-Veda, "a twine of seven threads" is specified, and "sewing," and again, "sewing with a needle"; while, in a hymn to Apris, occurs the line: "Day and Night spread Light and Darkness over the extended Earth, like two famous female weavers weaving a garment." The Yajur Veda particularises the use of cloth of gold as a counterpane; and in the Ramayana and Mahabharata, cotton, silken, and woollen stuffs are constantly denominated, and in a way that shows they were identical with the brightly coloured and harmonious embroideries and brocades now made in Cashmere, and at Lahore, Delhi, Dacca, Tanjore, Madura, Morshedabad, Benares, and Ahmedabad. Yet, strangely enough, the first mention of "needleworkers," *sûchika*, is in the Amara-Kosha, or Vocabulary of Amara; and the first appearance of needleworkers, as an expressly defined caste, *Sûchaka*, in the Ausanasa Dharmashastra, one of the Upa-Puranas. Another remarkable circumstance in connection with the needlework of India is that, as in the case of weaving, it has always, at least in modern times, and for commercial purposes, been, with the rarest exceptions, done, not by women, but by men. Elsewhere, all over the world, it has ever been emphatically a woman's art. In Egypt its patroness was Isis, and in Greece Pallas Athene, whose sacred peplum,

annually renewed by the noblest maidens of Athens, was borne in triumph, during the great Panathenaic Festival, to the Acropolis. The Chinese attribute its origin to the wife of the Emperor Yao, and the Peruvians to Mama Ella, the consort of their first king, Manco Capac. The fact that Bezaleel, the son of Uri, and Aholiab, the son of Ahisamach, superintended the embroideries of the Hebrew Tabernacle (Exod. xxxv. 30-35, xxxvi., and xxxviii. 22,23), would seem to indicate that, at least among the Semitic natives of Anterior Asia, embroidery may have been done by men, who in the course of the trade of the Sabæan Arabs in the Indian Ocean, introduced its practice by men into India. But a careful reading of the passages in Exodus recounting the labours of Bezaleel and Aholiab indicates that they were rather the general designers of the whole of the ritualistic decorations of the Tabernacle, in stone and metal work, and textile hangings, than actual embroiderers; while the allusion in the Song of Deborah (Judges 5) to the "wise ladies" of "the mother of Sisera," in connection with "a prey of divers colours of needlework," feigned to have been divided out to Sisera; in Psalms xlv. 14, to the virgin companions of "the daughter of Tyre", in connection with "raiment of needlework"; and in 2 Kings xxiii. 7 to the women who "wove hangings for the grove"; and the explicit statement in the Iliad, vi. 291, that the "variously embroidered robes," of Hecuba, were the work of Sidonian maidens, all prove that Semitic women were the producers not only of domestic and sacred embroideries, but also, in part at least, of the commercial embroideries exported throughout antiquity from Anterior Asia.* On the Egyptian monuments at Beni-Hassan, the spinning and weaving represented are both done by women; who are, however, assisted in dyeing the threads by men, and are apparently superintended throughout all their operations by a man. Again, in the fictile art of ancient Greece, it is invariably women who are represented spinning, embroidering, threading the shuttle, and weaving, and never men. I have myself seen women weaving in India, but never, save for domestic purposes, embroiding; and, until Mrs. David Carmichael formed the present collection of embroidery by Indian women, I did not know of any needlework being produced by the women of India for sale, excepting the *phul-kari* (*i.e.*, "flower-work") of the women of the subalpine Himalayan region of the Tarai. The collection brought together by Mrs. David Carmichael is, therefore, of special interest; and its public exhibition in this country is not unlikely to mark a distinct step in the advancement of the education of the women of India in a direction for once happily in complete consonancy with their inherited indigenous culture. Unfortunately, the collection, judged by its intrinsic merits, is very disappointing. It demonstrates, indeed, the presence of widespread accomplishment—in the conventional, not the etymological meaning of the word—but also, the widest absence of that absolute artistic achievement which imparts even to a scrap of needlework a beauty moth and rust cannot corrupt, nor thieves break through and steal, for, once its fair idea, or divine archetype, as a Platonist would say, is realised, it lives for ever, a heavenly treasure, in the memories of men.* Only one article in Mrs. David Carmichael's collection shows even perfected manipulative skill, a wonderful piece of *appliqué*, wonderful for its patiently elaborated dexterity of cutting and stitching, yet wanting in just this spiritualising element of illusion, the highest magistery of craftsmanship, which, in the radiant robes and the enchanting girdles embroidered by the women of Sidon, repeatedly inspire, as I have shown, the sympathetic wonder and immortalising praise of Mæonian Homer, first of the greatest artificers of song.

* Yet the fact must be noted that all the Arabesque embroidery of Egypt is to this day done by men, who are always Greeks.

* As an illustration of the magic sleight of the "tactus eruditus" in the very humblest departments of artistic creation, I am tempted, in the present association, to instance the crape and cambric caps (kerchiefs, *i.e.*, *couvre-chefs*) worn by the gentlewomen in the recently exhibited studies by Downman for the portraits of the more or less distinguished English people painted by him during the opening years of the closing century. They are drawn with the unerring, finished touch of complete mastery of a pencil answering instantly, and as it were spontaneously, and with the easiest and fullest expressiveness, to his mental pattern of them; and whether adding dignity to some aged matron's thoughtful features,

"——kercheft in a comely cloud,
While rocking winds are piping loud,"

or giving piquancy to a young girl's blooming face,

"The Cynosure of neighbouring eyes,"

they are, in their grace of happy propriety and simple refinement, truly classical ideals of all that is modest and most becoming in female head-dress; ideals the deftest of Parisian milliners might despair of realising, in even the lightest of muslins, laces and ribbons, with any approach to the fantasy and perfection of fashion given them by Downman, unless possessed also of the true artist's insight for that spiritual beauty in things natural, which never can be perceived by the outward eye, and is comprehended only by the mind of man; —"quod neque oculis, neque auribus, neque ullo sensu percipi potest; cogitatione tantum, et mente complectitur."

PRODUCTION OF JUTE AND SAN FIBRE IN INDIA.

Jute is largely cultivated in the northern and eastern districts of Bengal, and, to a smaller extent, in the central districts of the province. It is grown also, although not extensively, in Assam. The United States Consul-General at Calcutta says that jute seems to be capable of cultivation on almost any kind of soil. It is least successful, however, upon laterite and gravelly soils, and most productive upon a loamy soil or rich clay and sand. The finest

qualities are grown upon the higher lands, upon which rice, pulse, and tobacco form the rotation. The coarser and larger qualities are grown chiefly upon mud banks and islands formed by the rivers. When the crop is to be raised on low lands, where there is danger of early flooding, ploughing begins earlier than upon the higher lands. The preparation commences in November or December in the low lands, and elsewhere in February or March; the soil is ploughed from four to six times, the clods pulverised, and, at the final ploughing, the weeds are collected, dried, and burned. No special attention is paid to good seeds, nor do cultivators buy or sell their seeds. In the corner of the field a few plants are left to ripen and produce the seed that is sown broadcast the following year. The sowings, according to the position and nature of the soil, begin about the middle of March and extend to the end of June. The time for reaping the crop depends entirely on the date of sowing, the season commencing with the earliest crop about the end of June and lasting until October. The crop is considered to be a season whenever the flowers bloom, and to be past the season whenever the fruits appear. The fibre from plants that have not flowered is weaker than from those in fruit; the latter, though stronger, is coarser and wanting in gloss. The average crop of fibre per acre is over 1,200 lbs., but the yield varies considerably, being as high as 4,000 lbs. in some districts, and as low as 250 lbs. in others. At present, as practised by the natives, the fibre is separated from the stems by a process of retting in pools of stagnant water. In some districts, the crop is stacked in bundles for two or three days to give time for the decay of the leaves, which are said to discolour the fibre in the retting process; in others the bundles are carried off and at once thrown into the water. In some districts the bundles of jute stems are submerged in rivers, but the common practice seems to be in favour of tanks or roadside stagnant pools. The period of retting depends upon the nature of the water, the description of fibre, and the condition of the atmosphere, and it varies from two to twenty-five days. The operator has, therefore, to visit the tank daily to ascertain if the fibre has begun to separate from the stem. This period must not be exceeded, otherwise the fibre becomes rotten, and almost useless for commercial purposes. The bundles are made to sink in the water by placing on them sods and mud. When the proper stage has been reached, the resting is rapidly completed. The labourer, standing up to his waist in the water, proceeds to remove small portions of the bark from the ends next the roots, and grasping them together, strips off the whole from end to end without breaking either stem or fibre. Having brought a certain quantity into this halfprepared state, he next proceeds to wash off, which is done by taking a large handful, swinging it round his head, dashing it repeatedly against the surface of the water, and drawing it through the water towards him so as to wash off the impurities; then with a dexterous throw he spreads it out on the surface of the water and concludes by carefully picking off all remaining black spots. He then wrings it out so as to remove as much water as possible and hangs it up on lines prepared on the spot to dry in the sun. There are in India 26 jute factories, 8,101 looms, and 161,84[illegible] spindles, which give employment to 61,915 persons and consume 2,869,088 cwts. of jute. They are almost exclusively employed in the gunny bag or cloth trade, a few only doing business in cordage, floor cloth, or other manufactures. San or sunn is grown by itself, or at times is raised in strips on the margins of fields, and is never cultivated as a mixed crop. It is usually sown in June or at the beginning of the rains, and cut at the close of the rainy season—about the 1st of October. It requires a light, but not necessarily, rich soil, though it cannot be grown on clay. It is believed by cultivators to improve the soil; and as it is supposed to refresh exhausted land, it is considered a good preparatory crop, and is grown as such, every second or third year, in fields required for sugar-cane and tobacco. The ground is roughly ploughed twice and the seed sown broadcast, and as it germinates immediately, appearing above ground within 24 hours, no weeding is required. From 12 to 80 lbs. of seed are used to the acre, the opinion prevailing, however, that thick sowing is more desirable. Ordinarily the crop is harvested after the flowers have appeared, but the plants are frequently left on the field until the fruits have begun to form, and sometimes until they are ripe. There is a great difference of opinion as to whether the crop should be dried before being steeped, or carried at once to the retting tanks. When stripped of the leaves, which are highly esteemed as manure, the stalks are made up into bundles and placed upright for a day or two in water a couple of feet deep, since the bark on the butt is thicker and more tenacious than that on the upper portion, and, therefore, requires longer exposure to fermentation. The bundles are then laid down lengthways in the water, and kept submerged by being weighted with earth. It can generally be ascertained when the retting is complete by the bark of the lower ends of the stems separating easily; but too long fermentation, while it whitens, injures its strength. Having discovered that the necessary degree of retting has been attained, the cultivator, standing in the water up to his knees, takes a bundle of the stems in his hand and thrashes the water with them until the tissues give way and the long clean fibres separate from the central canes. When the fibre has been separated and thoroughly washed, it is the usual custom to hang it over bamboos to be dried and bleached in the sun. When dry it is combed, if required for textile purposes or for nets and lines; but if for ordinary use for ropes and twines, it is merely separated and cleaned by the fingers, while hanging over the bamboo. The output per acre of san fibre ranges from 150 to 1,200 lbs.,

ut the estimated average is 640 lbs. to the cre. The chief purpose for which san is utilised t the present day is the manufacture of a oarse cloth or canvas, used principally for sacking. A large amount of the fibre is used in the native ordage trade, for which it is stated to be well dapted, and considerable quantities of the fibre are lso consumed by the European rope makers in ndia. The waste tow and old materials are made nto paper. In many districts paper is regularly nanufactured of this material, and large quantities re used by the Indian paper mills. In some parts of India the seeds of the san are collected and given o cattle. The plant itself is found to be very nourishing, causing cows to give a larger supply of milk.

UNITED STATES PITCH-PINE INDUSTRY.

The British Vice-Consul at Pensacola says that he immense quantities of pitch-pine wood hewn, sawn, and manufactured, which have been shipped from the United States—notably to the United Kingdom—for so many years past, and which are still being shipped without any diminution, leave it apparent that information on this subject, generally, and particularly on the probable length of time that these pitch-pine forests will hold out, will be of value and interest to the principal dealers in this great article of trade. The pitch-pine trees of the Southern States are of spontaneous growth, and especially indigenous to those sandy soils near to the water of the Gulf and Atlantic coasts, and, therefore, hardly any attention is given to the culture of these trees. It is believed that the pine wood of the Southern States is coming more and more to the front, and that it is the most valuable wood of the country for mercantile purposes, and that, as the white wood of the Western and Eastern States becomes exhausted, the Southern States will be more relied upon. It is stated by the Forestry Bureau of the Department of Agriculture in the United States that there are about ten species of merchantable pine in the Southern States: the white pine and pitch-pine, the scrub or spruce-pine, the sand-pine, the pond-pine, the cedar-pine, and the long-leaf, short-leaf, loblolly, and Cuban pines, which are the principal varieties in general use. There is a great deal of confusion arising from the indiscriminate use of local names for these timbers. Thus the long-leaf pine is called yellow pine, hard-pine, pitch-pine, and various other names, but the settled name of this species of wood for commercial purposes at Pensacola is pitch-pine, and this quality of wood forms the largest if not the entire bulk of the shipments of pine wood from Pensacola. The short-leaf is called the old-field and spruce-pine, the loblolly fuel-swamp, sap-pine, and Virginia pine. The most important of these woods —the long-leaf pine—grows in the Atlantic and Gulf States, at some distance from the coast, covering a belt of about 125 miles in width. Next in importance to the long-leaf pine—pitch-pine—is the short-leaf pine, and this is more widely distributed than any of the other growths of pine. It is the predominating growth in some of the Southern States, and it covers immense areas to the exclusion of almost every other tree. In Florida the short-leaf pine is found along the northern border of the State. In Western Florida, nearer to Pensacola, it approaches the Gulf within 25 miles. It is said that the short-leaf pine gives from 3,500 feet to 4,000 feet, board measure, per acre. A rough estimate places the possible standing timber of this species, distributed throughout the Southern States, at about 160,000,000,000 feet board measure. The loblolly pine is found only in the northern part of Florida, and the Cuban pine is found principally in Florida and along the Gulf coast. It grows mainly on the so-called pine flats or pine meadows. About 12 years ago the official estimates of the merchantable pine timber standing in the Southern States gave a probable quantity of 225,000,000,000 feet. Since that time there has been an enormous quantity of timber cut, but the amount standing now is estimated as follows:—Long-leaf and Cuban pine, 232,000,000,000 feet; short-leaf pine, 160,000,000,000, and loblolly pine, 102,000,000,000 feet, making a total of 494,000,000,000 feet, board measure. The long-leaf pine is known to be superior to all the other species in strength and durability. In tensile strength it is said to approach, and perhaps surpass, cast-iron. In cross-breaking strength it rivals the oak, requiring, it is stated, 10,000 lbs. pressure per square inch to break it. In stiffness, it is superior to oak by from 50 to 100 per cent. It is best adapted, and much used, for the construction of heavy work in shipbuilding; the inside and outside planking of vessels taking the deals and planks of the best quality. For house-building it is used almost entirely in the district of Pensacola, and in buildings for railroads, railroad cross-ties, viaducts, and trestles, this wood is foremost. The finer grades and the "curly" woods are very much used for the timber work in the best dwellings. The hardness of this wood especially fits it for planks and flooring. The finer grades of curly-pine are used for the manufacture of furniture, and it is said that for bedsteads it is admirably adapted, as the resinous wood prevents the inroads of insects and similar pests. The resinous products of pine wood supply many parts of the world with pitch, resin, and turpentine. And, contrary to opinion formerly held in this respect, it is said that the tapping of the pine tree for turpentine strengthens, instead of weakens, the wood. The Cuban pine is like the long-leaf pine, and is used in trade to a large extent. The short-leaf pine is a softer wood, and is more easily worked. This wood is admirable for house work, and is largely used by builders and cabinet-makers, and for other purposes. The loblolly pine is suited for rougher

work than the other two species, but it is not so strong, and it will not last so long as the others. It is stated, in a recent report of the United States Department of Agriculture, that in respect of the pine forests of the Southern States, the supply is good for fifty years to come.

VEGETABLE FIBRES IN THE ARGENTINE REPUBLIC.

The United States Consul at Buenos Ayres says that one great drawback to the production of native fibre in the Argentine Republic is the lack of proper machinery and the want of enterprise sufficient to procure it. There are numerous varieties of plants growing spontaneously in the country which produce a very superior fibre. To some extent these have been used, and are still used, not only for cordage and rope, but for bagging and other more delicate textile fibres. The most common of these are the following:—The *agave*, which is called *pita* in the country. It is the same plant as that so well and so favourably known in Mexico, and it has all the same qualities and characteristics. The *caraguato*, the usual name for which is the *chaguar*, was employed by the Indians before the Spanish conquest, and has been used by the Argentine people of the interior in a primitive domestic way ever since. It grows with especial luxuriance in the Gran Chaco, and in one part there is a natural growth of it of upwards of 100 square leagues in extent. The Indians produce from it a thread with which they make their fishing nets, and also the few garments which they wear, the latter being generally dyed in various colours. The Argentine women of the upper provinces, with their hand looms, also make various fabrics, some of them of excellent quality. In former years there was a question of the export of this fibre, but the difficulty was in preparing it for market in sufficient quantities, owing to the want of labourers, and, in the second place, it was found that the roads between the frontiers and the Parana or Paraguay rivers were so few and so bad that the cost of transportation would absorb all the prospective profit. It has been stated that the fibre of the *chaguar* will compete with the hemp of Manila, which is said to be less uniform and durable. In some of the upper provinces, *canamo*, or hemp, has, to some extent, been cultivated for many years for its fibre. It grows, however, almost spontaneously, and although the soil of the country gives it an excellent fibre, there is not yet sufficient enterprise to do much with it. Linseed is grown in great quantities, especially in the province of Buenos Ayres and Santa Fé, but, hitherto, it has been produced more for the seed than the fibre. The exports of linseed, in 1890, were 30,720,636 kilogrammes, and in the first nine months of 1892 they amounted to 44,160,163 kilogrammes. From these figures it will be seen that the amount of fibre left for home consumption must have been very considerable. Besides the above, there are numerous plants, especially in the Gran Chaco, known only by the Indian or Guarani name, which produce fibre of more or less excellence. One of these is the *caza-guatá*, a species of aloe, which grows spontaneously, not only in the Gran Chaco, but in Paraguay. A few years ago a firm of American merchants at Buenos Ayres, who own an extensive tract of land a few leagues above Asuncion, on which this plant grows in a very rank condition, undertook the production of fibre, not only for rope and cordage, but also for woven goods. The tests which were made by experts from the United States were most satisfactory, the fibre, as they reported, being equal, if not superior, to any produced in the world; but the field of operation was so inaccessible and so remote from market, that the industry was given up. There is, however, believed to be a field for this fibre fully equal to the one which Manila enjoys. Jute is not cultivated, not because it could not be grown to advantage in many parts of the Argentine Republic, but because, in a new country like Argentina, there is not the enterprise or manual labour to cultivate it. All the jute used in manufactures, or at least a very large proportion of it, is imported from abroad. For several years experiments have been made in Buenos Ayres with the ramie plant, and they have been so satisfactory, that a company has been formed in that city to grow the plant in large quantities in the southern portion of the Gran Chaco. Consul Baker says that in the Argentine contribution to the Chicago Exhibition, there will be found a full and interesting display of all the textile plants grown in the country, the whole number amounting to 140 varieties, not including the cotton plant.

General Notes.

ANTWERP INTERNATIONAL EXHIBITION.—The "programme général" of the Exposition Universelle d' Anvers to be held from May to November, 1894 has been issued, together with other information useful to intending exhibitors. The Exhibition will be under the patronage of the King of the Belgians, and the Comte de Flandre is President d' honneur. The Executive Committee is presided over by the Comte de Pret Roose de Calesberg, senator, while M. Henri Béliard is the administrateur-secrétaire, and M. Vercruysse-Bracq, senator, Commissaire-Général of the Foreign Sections.

The Telegraphic Address of the Society of Arts, and of the Royal Commission for the Chicago Exhibition is "Praxiteles, London."

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

THE ROYAL MARRIAGE.

The following address to H.R.H. the Prince of Wales, President of the Society, has been presented to his Royal Highness :—

To His Royal Highness the Prince of Wales, K.G., *President of the Society for the Encouragement of Arts, Manufactures, and Commerce.*

May it please Your Royal Highness,—

We, the Council and Members of the Society for the Encouragement of Arts, Manufactures, and Commerce desire to express to your Royal Highness our respectful and hearty congratulations on the marriage of His Royal Highness the Duke of York with Her Serene Highness the Princess Victoria Mary of Teck.

"We pray that this auspicious event may be a source of true and lasting happiness to the illustrious bride and bridegroom, and to the Royal Family, and prove a blessing to the nation."

Signed and sealed on behalf of the
Council and Members of the Society by

Richard E. Webster,
Chairman of Council.

Proceedings of the Society.

CANTOR LECTURES.

SOME MASTERS OF ORNAMENT.

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I am not altogether satisfied with the indeterminate title of these lectures. It should have been *the* masters of ornament; but who are the masters? That is a question no man can well determine, not because one would have any hesitation—certainly I should have none —in placing first those one thought worthiest, but because the masters of ornament, perhaps because it is only of ornament that they were masters, are for the most part quite unknown.

History tells us next to nothing of the workmen of ancient or mediæval times, nor do we know much more of the personality of those Oriental artificers to whom design seems to have been verily a second nature, ornament a sort of second speech, or rather, one might say, spontaneous song.

Even when by chance mention happens to be made in documents sufficiently authentic of the name of some cunning workman, one can never be quite sure as to what is actually due to him. Any great reputation absorbs the lesser reputations which go to make it; and the fame of the ornamentist in particular is apt to be swallowed up in that of the more illustrious fine artist with whom it is his lot to be associated. That is not very much to be wondered at; it is perhaps only natural; but it is unfortunate for the artist whose work happens to be merely ornamental, and unfortunate perhaps for ornament—seeing that there is so much the less temptation to an artist of any ambition to enter the ranks of design, so much the less inducement to remain in them once there.

Account for it as we may, the fact remains that it is quite impossible to identify, at this date, the greater number of even the most accomplished artists in ornament. It is not until the Renaissance, or until the spirit of the Renaissance is in the air, that the individual ornamentist begins occasionally to emerge from obscurity; and, until quite modern times, it was no uncommon fate for him to work and die unknown beyond the workshop. The nearer the work approaches our own time the more likelihood is there of our knowing who it was that did it; and, as the progress of ornament from the 16th century to the 19th has been in the main from good to worse, one may almost say that our knowledge of the man responsible for the work is in inverse ratio to its merit, or that the poorer the art the more we know about the artist. At any rate, it is only of *some* of the masters that we can speak with anything like certainty. And if these happen not always to be the worthiest, or if it is not always of the most worthy that there is most to be said, that is one of those unfortunate circumstances for which no one in particular is responsible: we can only discuss that of which we have means of knowing something. Still, it would be hard if some good did not come out of any inquiry con-

ducted with the desire really to get at the truth.

What matters it about the workman, it may be asked; the work is there for our delight and inspiration. It is that which vitally concerns us; never mind who did it. That is so. But apart from the desire to do justice to the workman, and the personal interest in him which workers in the same art naturally feel, some knowledge of the man, his circumstances and surroundings, cannot but help us better to understand and appreciate the work he did.

Another difficulty in dealing with the earlier masters is, that we have to do with times when all art was decorative, more or less, or, at any rate, confined within limits which we now define as decoration, and when the painter, the sculptor, the engraver, and whoever was concerned in art, were one and all ornamentists also in a way; and, as a matter of fact, we know that it was out of the ranks of ornamentists, goldsmiths, and the like, that the first painters came.

If, however, it were attempted to review those painters, sculptors, and others, in whose work is included something of ornamental design, there would be literally no limit to these lectures. The utmost it is possible to do is to call attention to those among them who distinguished themselves in ornament, whose names are by rights associated with it, and who seem to have had a vocation for it. Even then, there are many famous names connected with design, and even with ornamental design, which my scope compels me to pass briefly by, if I so much as mention them at all.

May I confess a certain scepticism as to the many many-sidedness of all but a very select few of the past? Doubtless, it was more possible in days of old than now it is to be proficient in several kinds of art. Art was then more one; it was not the fashion to specialise; there was no such extraordinary *prestige* attached to the painter as to lift him altogether above the goldsmith or the bronze-founder: the artist was a craftsman first and last. Moreover, the limitations of the artistic horizon—the fact that a man had no concern about styles or style, but worked serenely on in the manner of his day, and that the fashion changed but slowly, as compared with the hey-presto transformation scenes of to-day—all this made it possible for him to be up to date, perhaps, in several crafts. Here and there a giant among them may have been master of all the arts; but, even in those days, giants, one is inclined to believe, were not quite so common as biographers would have us believe; and when we are informed that such an one was architect, painter, sculptor, engraver, soldier, engineer, philosopher, and poet, it is no more than reasonable precaution to take that statement with just a grain of salt.

We know how boastful some men are; we know how tempting it is to have a finger in the pie (though we be anything but expert in cookery); we know how a man distinguished in any sort is accepted without question as an oracle on any and every subject; we know how insatiable a great reputation can be, and how greedily it devours the smaller fry that come within its range. And of this small fry the ornamentist is one of the first to be gulped up. His identity is lost in that of the sculptor who carved the figure work associated with his ornament, or both identities are merged in that of the architect. Later it was the painter who predominated and stamped his name, so to speak, on all the lesser arts—and that, although he were no Raffaelle, but only a Rubens or even a Le Brun.

The fact is there were editors in those days also, and editors, too, who were not content with suppressing the names of their contributors, but who would have had us believe that the staff were mere hands, obedient to, and dependent upon, the genius of Pecksniff.

When, therefore, the details of ornamental painting or carving are attributed to a man whose hands were obviously so full, with other and bigger work, that it is impossible he could have found time for such minutiæ, and when in such detail there seems to be nothing to indicate that he had any hand in it, when it has perhaps a character to be found in other work with which he had certainly nothing to do, then, although it may be difficult, or even impossible to identify at this time of day the man who really did it, one may safely conclude that the utmost that belongs to the great man is the credit of having employed a good workman—for, then as now, the administrator of any great and comprehensive artistic undertaking was dependent upon the support of a number of artists, some of them his inferiors, if at all, only in administrative ability.

Raffaelle, for example, was only one, although in his own line by far the most brilliant, of a brilliant group of decorators—and it would be as absurd to suppose that he is individually responsible for all that is now attributed to him, as to imagine that Wren, in the midst of rebuilding the City of London,

with dozens of churches on his hands, St. Paul's, and heaven knows what besides, could by any human possibility have given anything more than a very casual attention to the ornamental details of his buildings. The style of Grinling Gibbons would have been a little less loose, perhaps, if he had.

The identity of the majority, lost in the sound of a few sonorous names, it is now too late to discover; I propose to attempt very little in that way. I am very far, indeed, from professing to have found out anything new about the masters of ornament: ornament, and not the masters of it, has been my study in life; and my interest in the men, I may confess, was aroused only as I got by experience inevitably to know more of them. I am very much in the position of Mrs. Jamieson, whose prettily expressed apology to her readers would suit my case at least as well as hers. I have had a peep through the gateway into a new field of study, and am eager to call my companions and fellow-workers to come and see also what I have been fortunate enough to catch a glimpse of.

What I do bring to the study of the masters is an acquaintance with ornament more intimate than the historian is likely to possess; and, if I cannot claim to have unearthed any buried reputation, I can hope to point out which of the well-known men were masters of ornament, and which of the less famous deserve the title of master.

But what I have mainly to talk about is their work; and, I take it, you do not so much come here to learn from me historic facts, which you could gather for yourselves from books already published, as to hear what this workman may have to say about those workmen in whom he recognises his masters.

And you must look to me for no impartial judgment—rather the reverse. Strive as he may, and as an honest man will, to be fair, an artist cannot but be prejudiced. He would be no artist if his sympathies were not so quickly kindled by work of some kinds that he scarce did justice to performance more remote from his tmperament. And an artist must judge according to his temperament; it is that which makes him an artist. With a mind quite free from bias he might have made, perhaps, a very excellent and worthy judge, but never an artist at all.

Now, as to who these artists were—who were the masters of ornament? Their names are a puzzle, to begin with. The ornamentist came, ordinarily, from a family which had no name—the great family of workmen, who were distinguished rather by the name of their native place than by a patronymic, for which they had perhaps not, as a rule, much use. One name was enough for a Christian. It was enough to distinguish John from Jacob, or John the carver from John the painter. And only when the Johns and Jacobs became too many, as in towns of any considerable extent they soon would of course, was it found convenient to call one John Jacobsson and another John Johnsson, and so *ad infinitum.* A stranger workman was habitually called after his native place: he was Nicholas of Pisa (one has to remember that Pisano was not a family name), Mino of Fiesole, William of Marseilles, or he was just called the German or the Spaniard. A nickname was thought quite enough to be known by. It may have been "John of the Bridge" or "James of the Oak." If he was short, he went by the name of the "little painter;" if he was a dandy, by the title of "little gentleman;" if his hair was red, he might simply be called "carrots;" all of which nomenclature may at the time have been distinctive enough; but, at this distance of date, it only seems to make history hazier than it need have been. And when learned gentlemen unearth the real name of the man, and would substitute it for the name we know, the confusion of the unlearned is worse confounded than ever.

In Italy—as though men's names were not already mixed enough—it was no uncommon thing for an artist to take on the name of his master, Sansovino, or whatever it may have been. That is a practice which may be attributable, in some degree, to hero worship on the part of the pupil. A man's artistic instinct would, doubtless, have prompted him to make a name for himself; but, on the other hand, there was money in the name of a distinguished master, and the pupil adopted it, or his master perhaps bequeathed it to him as a legacy—probably very much to his commercial advantage—just as now a days a man of business will, properly enough, carry on his trade under the name of no matter whom, so so long as it be better known in the market than his own.

Another difficulty in tracing the names of the masters arises from the haphazard way in which they are spelt. A Netherlander will spell his name in as many as half-a-dozen different ways—there is often a doubt even as to the initial letter of his name—one never knows whether to look among the Fs or the Vs

for it, and a syllable more or less at the end of the name counts for nothing. If no one had ever heard of Shakespeare until now there might be some difficulty in identifying him under the numerous forms of his name that have been adopted.

Our knowledge of the workman, as distinguished from his work, begins practically with the Renaissance ; the mediæval craftsman is, for the most, personally quite unknown to us, and unknowable. The assertion of the artist's personality is, perhaps, a sign of the Renaissance spirit.

The movement begins, as we know, in Italy, and it will be convenient, therefore, for us to begin there, with the men who initiated it, and then to follow it across the Alps, and see what Northern and Western artists made of it, as its influence penetrated through Europe.

Already, in the 13th century, when we in England were only beginning to perfect the earliest phase of Gothic art, the Pisan sculptors were going to the antique for inspiration—or perhaps it should be said it went to them and offered its beauty unbidden—for there had been brought to Pisa by the ships which put in at that port considerable spoils in the shape of Greek marbles, some of which are to be found to this day in the Campo Santo there.

But of Niccolla and his son Giovanni of Pisa (1205-1275), we have no evidence that they excelled in ornament at all ; nor do we know how far Arnolfo, the architect (1232-1310), is responsible, if at all, for the decorative detail of the Duomo at Florence, or whether Andrea Tafi, who designed the mosaics of the dome of the baptistery there, had any hand in the perfect ornamental inlay of its pavement—probably not since it was he who introduced into Tuscany what Vasari calls "the improved manner."

With the work of Giotto (1276-1336) we certainly do find a very characteristic form of ornament, that, namely, which was initiated from the geometric mosaics of the Cosmati, a most noted example of which occurs in the chapel of the Arena at Padua. You know the kind of thing: it is made up entirely of little squares and triangles, just as though it were actual inlay. It forms a very satisfactory framework to the pictures ; it has the merit of restraint and subjection ; but it is at best only an imitation. The merit of such invention as there may be in it belongs neither to Giotto, if he had anything to do with it, nor to the Cosmati, who popularised, if they did not introduce, the mosaic itself in Italy, but to the Mohammedans, from whom they borrowed it—as the Italians borrowed also, after the taking of Constantinople in 1204, that kind of interlacing ornament which is so characteristically Byzantine.

One other kind of 13th century ornament is found in association with Giotto's paintings. It consists of a variety of ornamental foliage about halfway between Gothic leafage and the classic scroll. That was imitated, I take it, from stone carving. It was usually unpretentious in design, well balanced and composed, but rather thick and clumsy in detail, with blunt outlines, and a certain leathery look, even when it was marble, as on the exterior of the Duomo at Florence and of the famous Campanile.

Something of the same character we find in the work of Andrea Orcagna (1308-1368), whose work brings us well into the 14th century. He was architect, painter, and sculptor, but he began as a goldsmith ; and it is not unlikely that he designed himself the ornamental details of his famous tabernacle in the Church of Or' San Michele. (Illustration shown.) The ornament there is carved in white marble, and the background is inlaid with coloured marbles. The design is singularly compact, and its breadth is not frittered away. Altogether it is rather a good specimen of early 14th century work—of the trecento, as the Italians call the period.

Parallel, if not precisely contemporary, with our English Decorated period, we find, in Italy, a very pronounced movement in the direction of naturalism. Natural foliage is as characteristic of the quattro-cento as of the style we call Decorated—only more so. It is the difference between the stalls at Amiens and the gates of the Baptistery at Florence.

Ghiberti (1381-1455) represents very fairly the art of the day, and had very likely a good deal to do with the direction it took. His famous gates, however, hardly come into the category of ornament ; and if Michael Angelo ever really meant that they were fit for the gates of Paradise, and was not merely indulging in compliment—well, he must have had a rather florid idea of Paradise.

In the ornament framing these same doors, Ghiberti shows himself master of everything *but* ornament. There is much to admire, much that every one must admire, in the masterly modelling of those borders, of which two specimens are shown upon the screen, but it is not precisely ornament. No one would

gather from it that he had ever studied in the workshop of his father-in-law the goldsmith. We have in Ghiberti one of the very few men of that early date of whom a modern realist might heartily approve. He was a law to himself. He belonged to no school, and, happily, he founded none. Surrounding one of the other doors there is some earlier foliage in very delicate relief (perhaps by Andrea Pisano), which is much more suggestive of paradisiacal calm than the more tormented detail of the popular artist, and much more ornamental.

Luca Della Robbia (1400-1481), although he also showed a leaning towards natural foliage in his design, treated it in a more decorative manner. He, too, was originally a goldsmith, and his early training in ornament stood him to the end in good stead. There is usually a breadth about the treatment of his favourite garlands of fruit and flowers which goes far to make them decorative, and some of his little flower panels are quite admirable. His rendering of ancient ornamental detail is graceful and free: it is neither quite like old work, nor quite like other men's rendering of it; and it has always the character of clay. A modeller could tell at once, from the character of the ornament in the pilasters on the screen that it was modelled, and not carved. Luca's delightfully ornamental treatment of cherubim may also fairly be called his own. No one knew better how to design a wreath of cherubic faces nestling among downy wings, and they fulfil the ornamental function of a frame or border perfectly. As colourists, neither Luca nor his successors were happy. There was some excuse for the white glaze with which he began by covering his terra-cottas—it served at least to protect the ware—the colour, which he afterwards added, was only one more misguided attempt in the direction of naturalism. It added, doubtless, to the popularity of his work, but by no means to its artistic charm. All sculpture may have at first been coloured, and as much like life as possible. A rude form of carving may have been all the better for it. It may be quite possible to reconcile the conflicting claims of form and colour in the shape of painted sculpture, only Luca did not do it, nor yet his successors.

There was quite a succession of Della Robbias, and we are rather apt to confuse their work. The most remarkable of the family, after Luca, were Andrea, the nephew of Luca (1435-1525), who modelled the dear little bambini on the façade of the hospital at Florence, and (1469-1529) Giovanni, the son of Andrea, who modelled the frieze outside that other hospital at Pistoja. Another son of Andrea's went to France (1488-1566).

Desiderio da Settignano (1428), who was the son of a mason, began, no doubt, by cutting his teeth, so to speak, on ornamental work, and never lost his taste for it. He and Mino Da Fiesole (1431-1486) worked at one time together, and the manner of the two men is very similar. Vazari calls Mino the pupil of Desiderio, on whom, he says, Mino founded himself so much as to seek the grace he gave to his figures rather than the natural truth. The all-important thing, so far as ornament is concerned, is that they did both seek that same grace, which is the excuse for ornament. A distinguished critic calls their work "dry." I notice that whenever a man by chance shows any sense of severe restraint in design lovers of the florid call his work hard and dry. If that monument is dry, why then I like my sculpture dry. How far the design on the screen is original it is difficult to know. There is almost its counterpart in the Church of S. Domenico, at Bologna, by Francesco di Simone, who was a pupil of Verrocchio, but that is dated 1477, and Desiderio da Settignano died in 1464—so that he at least has the priority. Possibly both men founded themselves upon a common original. Anyway this is very beautiful work, and quite characteristic of the period.

Andrea Mantegna (1431-1506) can hardly be omitted from the list of those who have shown some mastery of ornament. His love for it is manifest in the details of those famous designs of his we are so fortunate as to have at Hampton Court, details which give them no little of their richness, and place them among decorative as distinct from pictorial designs. Mantegna evidently was very seriously caught by the classic fever: a great part of his ornament is not so much founded on the antique as taken from it. Apart from his tapestry cartoons he produced sundry designs for decorative pilasters, helmets, and one gold cup (engraved by Hollar) which, is in its way most certainly a masterpiece. His influence on painting was probably as great as Donatello's upon sculpture. It was especially marked in Germany, where some of the "Little Masters" (of whom I shall have something to say in a future lecture) founded themselves very deliberately upon his printed work.

Donatello (1386-1468), by the way, is a master,

I may almost say the master, of early decorative sculpture—no one certainly has treated low relief in a way more absolutely suited to the purpose of architectural enrichment—but I know of nothing in the way of ornamental design which can safely be attributed to him.

Luca Signorelli (1440-1521) is credited with having initiated that system of working almost entirely through the human figure, which Michael Angelo brought to perfection. If that be so, he may be said to have initiated the most disastrous false start ever made in ornamental design.

The theory of the necessity of figure work in ornamental design, whether as a means to the mastery of ornament, or as a means of dignifying it, is a hobby-horse which has run away with most of those who set out to guide us in design.

But Signorelli himself shows, in his decoration at Orvieto, where he is quite at his best, that he could bring himself to ornamental arabesque, though it came easiest to him to make up his scroll of human instead of vegetable forms. And you see through it all that he felt the ornamental line, and it was that which suggested the figure to him. These are not figures taken from his sketch-book and made to do duty for ornament. He wanted such and such lines for purposes of ornament, and those lines suggested to him figures human or animal, and the action of the figure suggested its occupation. It is as clear to me, and I hope it is to you, that Signorelli was trying in that pilaster on the screen for ornament, as that the figure was his natural mode of expression. Had he respected ornament less, he would never have designed like this; had he been less at home with the human figure in its every movement, he could not have done it.

The moral is this. If you are a figure draughtsman, and do not respect and care for ornament, leave it alone; if you are an ornamentist, and do not know the human figure thoroughly, leave that alone.

The next name I have to mention is that of Andrea Sansovino (1460-1529). The Sansovini, it has been said, exaggerated the *naïveté* of the earlier Renaissance manner, and pushed its picturesqueness into florid luxuriance of detail.

That criticism is hardly borne out by the famous monument to the Cardinal Ascanio Sforza, in the Church of S. Maria del Popolo at Rome, of which I show on the screen the most important ornamental feature. To me, that is a model of delicate and refined enrichment, which places its author in the very first rank of ornamentists. The human face, from which the ornament springs, is not a happy thought; but the lines of the ornament, its distribution and balance, the grace, lightness, and beauty of it leave little to be desired. No one would gather from that that its author began life as a cattle herd. He has writ his name very large upon it.

It is not surprising that Michael Angelo, (1474-1563), whose idea was "the human form divine," and whose aim it was to express himself through it, should not have concerned himself much about ornament. His idea of decoration appears to have been to make use of architectural forms as a framework for his figures; and never by any chance did he attempt, like Signorelli, to make them into ornament; that would have been, in his eyes, to degrade them no doubt. But he had no compunction about degrading architecture to his purpose, and, notwithstanding that it was the fashion to make pedantic display of scholarship and erudition, he never for a moment hesitated between purity of style and picturesqueness. The use he made of architecture was purely decorative: he handled it much as a scene painter might do; he piled order upon order, and grouped together pilasters, niches, cornices, much as suited the convenience of his figure compositions. If not the first to use the broken pediment, he was the arch sinner in that respect; he did just as he pleased, and allowed himself a degree of liberty which at least implied the license of the later Renaissance. Michael Angelo himself had a fine sense of dignity, which prevented him from descending to the devices of his imitators; but there is no doubt he opened the way to the extravagances of men who were restrained by no such artistic sense as his. It takes, perhaps, a genius to show us how to go wrong.

It is strange that so serious a man, and a sculptor too, should, by his wilfulness, have initiated a style of art absolutely without seriousness; for he was really of much too serious a turn of mind to care for ornament, any more than, according to his latest biographer, he cared "for the loveliness of jewels, stuffs, and natural objects, for flowers and trees and pleasant landscapes." He was a giant in decoration—the giant, I may say—but not a master of ornament—a little art, but, like other arts, only to be mastered by love.

Once past his 'prentice days, this great

designer probably never designed a bit of ornament. But he had working under him at least one very capable sculptor of arabesques. In the carved desk-ends in the Laurentian Library at Florence, which the master is said to have designed, in the marble candelabra in the chapel of the Medici, where the famous tombs are, and in the ornamental details of the monument to Julius II. at S. Pietro in Vincoli, at Rome, which he quite certainly did not design—the same hand is to be traced, and it is the hand of a master. There is a character, an individuality about this arabesque which distinguishes it even among the admirable ornamental carving of the cinque-cento, and which has made me anxious to find out who it was that did it.

The name of Battista Del Cinque is mentioned in connection with the desk-ends—but then one is told that he was only the joiner—Carola and Tasso again are the names of carvers employed by Michel Angelo, the Gian-Battista Tasso, who ran away from home with Cellini, and went with him to seek fortune in Rome. Cellini speaks of him as an excellent carver; but then, later on, he calls him a carpenter. So it would seem that carving and carpentry went together in those days, and possibly Battista del Cinque was the man after all.

It is at least within the bounds of possibility, and even of likelihood, that Benedetto Da Rovezzano (1474-1552) may have assisted Michael Angelo—he helped him at all events in casting his bronze David, and may quite well have done other work for him. Benedetto's ornament has at least something in common with that I have been describing. Whether it was foliage or grotesques he carved, it was as if the stone blossomed into ornament; it seemed as if it must be so. There was never the least suspicion of effort about it; his touch, quite firm always, never in the least loose, was as light as light could be. Probably his most important undertaking was the monument to San Giovanni Qualberto—long since destroyed. But there are fragments of it preserved in the Bargello at Florence—in a little room on the ground floor, just off the courtyard—where also there is, I think, a mantelpiece by him, in that dirty brownish stone which, for a while, was fashionable in Florence, and certainly a lavabo of his—that shown on the screen. (In the Church of the Carmine at Florence there is a monument by him to Piero Soderini.) Da Rovezzano was no stay-at-home. He was born at Pistoja. Thence he gravitated naturally to Florence; and about 1524 he came to England, where he was engaged upon a monument for Wolsey, when the great Cardinal fell. Henry VIII. commissioned the artist to complete the work for him; but in the succeeding century (1646) the Republican Parliament decreed its destruction, and all that is known to remain of it is the sarcophagus now doing duty as Nelson's tomb in the crypt of St. Paul's—the one spot of beauty, simple as it is, in that dreary monotony of ill-carved churchyardery. Possibly, also, some scraps of frieze and pilasters lately put together in the shape of an altar-table in the choir of Westminster Abbey may have belonged to it. The ornament in these last is exceedingly delicate. It was certainly executed by an Italian master, and the Tudor emblems incorporated in the design go to suggest, if not to show, that it was executed for the king. Benedetto, it seems, returned to his own country and invested his savings in land at Rovezzano, and settled there — whence his appellation, Da Rovezzano.

There is a connecting link between him and the Florentine, Jacopo Sansovino (1479-1570); indeed, Jacopo is said to be responsible for the architectural part of the design of the lavabo just shown, and Vasari ascribes to him a similar part in the mantelpiece I spoke of in the Bargello. But great as was the fame of Sansovino the Second as architect and sculptor, he does not seem, except in the well-known gates of bronze in the choir of S. Marco at Venice, to have put his own hand to ornament. He was, perhaps, too much of a gentleman to have any occasion to do such work, for, unlike his master, he was of good family. Jacopo Tatti deigned, it is true, to take his master's name—but then the name of Sansovino was second only in repute to that of Michael Angelo!

I wonder how many of the tourists who pass through the door leading from the nave of the cathedral at Siena into the Sala Picolominea, where are the decorations of Pinturicchio and the famous choir books, stop to look at the doorway with its frame of little panels in coloured marbles, and its exquisitely delicate sculpture. Yet, in proportion and detail, it is about as perfect as the decoration of the library itself.

This is the work of Marrina, an earlier work I take it than the superb high altar in the church of Fontegiusta, in the same city, a church which most visitors to Siena go to see

because it contains some supposed relics of Columbus and a bad picture by Peruzzi.

But it is worth a pilgrimage only to see Marrina's altar, of which you have some details on the screen. For its period (the artist died in 1534) it is distinctly florid; but given a certain rich redundancy, I do not quite see how ornamental carving could be better. In the face of work like that I confess I forget to be critical, and just let myself enjoy it.

The Renaissance of the 15th century, and of the first few years of the 16th, was inspired by the remains of ancient *sculpture*; of *painting* under the Roman empire, little or nothing was known, and the painter of the Renaissance borrowed his details at first from carving. It mattered the less to him, since no Italian had ever any scruples concerning the propriety of imitating in one material the characteristics of another; probably he preferred to simulate, for simulation is as natural as breathing to an Italian, who, so far from seeing anything shabby in it, seems to think only how clever it is of him if he can deceive you. It was never any hardship to the painter, therefore, to have to found himself upon sculpture; he did not even take the pains to translate the forms and effects peculiar to marble into forms and effects appropriate to painting; he just painted the semblance of ornament in relief, and made it look as much like the real thing as he could, so like in many instances, that when it is at some little distance from the eye, it is only by reasoning out the impossibility of its being in relief that one arrives at the certainty that it must be a sham.

But when, at the beginning of the 16th century (1506), the baths of Titus were excavated, and the ancient Roman wall-paintings then brought to light, nothing would do but they must imitate these, and imitate them they did—*ad nauseam*, I think, I may say; for it is easy to get sick of the very ill-digested details which they piled together by way of ornament, beautiful as the details sometimes were, and clever as the men almost invariably were who adopted this heterogeneous style of design.

These men will be best known as the school of Raffaelle; but Raffaelle's master, Perugino (1446-1524), was among them, and also that other elder pupil of Perugino's, Pinturicchio (1454-1513), neither of whom is likely to have taken his cue from an artist he had known as a youngster. We all know how difficult it is for any one who has known you when you were a beginner, and, shall we say, a comparative duffer, to realise that you can possibly be doing good work, not to say work much better than his own. That would be to acknowledge a prophet in his own country, and no mistake! Anyway, Perugino was in Rome in the latter part of the 15th century, and soon after (1500?) decorated the Sala del Cambio at Perugia, where we have some of the earliest, if not the earliest, "grotesques" in the style afterwards made so much of by his pupils, and their pupils again, some of whom carried the painting to much higher perfection, without greatly improving upon the design. Compared with later ornament, Perugino's design is restrained, but i is not the less decorative on that account The dark ground he mostly adopted for hi ornament, adds to the dignity of its *ensemble*

I show you a panel from the stalls at S Agostino, Perugia, carved by Baccio d'Agnol (1460-1543), from the designs, it is said, o Perugino, but I do not myself attach muc faith to that legend. Baccio was a ma of such repute that his workshop was a artistic centre, where men like Raffaelle Andrea Sausovino, and Benedettoda Majan were in the habit of foregathering; and i he could design the stalls of S. Maria Novella at Florence, why not these?

Pinturicchio (1446-1524), who worked unde Perugino, adopted also the already mentione dark ground in the work he afterwards did o his own account; and there is about his orna ment, as for example in the Sala Piccolominea two details shown (something which remind one of the hall of the money-changers). Whethe it is Pinturicchio one detects there, or the in fluence of Perugino one traces at Siena, I d not pretend to say. One thing is pretty certai that Raffaelle had nothing to do with it. Th idea of a famous painter of 50 going to a bo of 20 for his designs is preposterous, eve though that boy was Raffaelle. That Vasar should talk such nonsense only goes to sho the lengths to which people who should kno better will go in attributing good work alway to the man with the greatest name.

Two other men who had the start of Raffaell in the matter of age were Morto Da Feltro an his pupil Feltrini. Morto, who according t Lanzi, is identical with Pietro Luzzo da Feltro known also as Zarotto—I mention this only t show you how elaborately the names of thes Italians are sometimes disguised—was bor about 1474 and migrated in early youth t Rome, where Pinturicchio was already at wor upon the Papal apartments of Alexander VI

He was a very diligent student of the antiquities about him, and was perpetually copying the details of old work in Rome itself, at Hadrian's Villa, at Tivoli, and even at Pozzuoli in the environs of Naples. Raffaelle is known to have sent people all over Italy, and even to Greece, to make studies of old work for him, and Morto was doubtless one of those "grazers" whom the master "milked" as Goethe would have expressed it. To Morto da Feltro belongs the credit, such as it may be, of having more closely initiated the ancient grotesques and arabesques than had been done before. Still his heart seems hardly to have been in his work, for he was fired with the ambition of painting the figure, and went to Florence to see what Lionardo da Vinci and Michael Angelo were doing there. It was not until the sight of their accomplishment put out his hopes in that direction—he knew his masters when he met them at all events—that he settled down steadily to the art in which he was himself a master.

He was surpassed in some respects by his pupil, Andrea di Cosimo dei Feltrini, who was called Di Cosimo because he studied the figure under Cosimo Roselli, and Feltrini because he learnt to design arabesques under da Feltro—another instances of descriptive mystification. The work of the pupil was richer and more various than that of his master; he had more grace, more invention, and he ventured to depart from the antique and be, as every designer must be, a precedent to himself. He was considered, in his day, not to be surpassed. Great painters came to him for help; and Vasari does not hesitate to acknowledge his own indebtedness to him. He designed with never-failing variety decorations, festal and funeral, caskets, brocades, &c.; and it is he who is said to have introduced into Florence the art of decoration in sgraffitto, samples of which are still to be seen there.

Raffaelle (1483-1520) had not long come to Rome when the subterranean paintings were discovered. He was very young, and it is not surprising that a new fashion should have carried him along with it. Certain it is he was very much "in the movement," and, if not actually the prime mover in it, he assumed almost at once the leadership.

Judging from what one still sees of Roman wall-painting in the house of Germanicus, and the baths of Caracalla, or at Pompeii, and in the Museum at Naples, it is hard to understand the enthusiasm such work seems to have inspired in the painters of the 16th century. The sight of it made me wonder how far it may have been the Papal taste which prevailed, and whether Raffaelle and the rest may not have persuaded themselves to think as the all-powerful patron thought.

If that suspicion should do them wrong, if worldly wisdom went for nothing in their preference, and they were moved by sheer enthusiasm for this new phase of classic art, then it is their taste one must impugn, in preferring to the dignified remains of Greek and Roman sculpture, which had inspired the admirable art of the quattro-cento, these trivial, and altogether much less worthy, models. I have no intention of belittling Raffaelle, and am so far from endorsing the latest dicta of the critics of this *fin de siècle* as to recognise in his Madonnas the work of one of the world's masters; but one may see the master in him without admitting him to be more than man, or even admitting him to be master of an art to which, humanly speaking, it was impossible for him to have given much attention. Even in decoration, Raffaelle is not at his best. You see in the Vatican how, as he frees himself from the influence of his master, he strays further and further away from the paths of decorative restraint, until one is bound to suppose that any decorative quality there may be in his early work is due entirely to the traditions of the school in which he was brought up, and that his own personal bias was altogether in the direction of pictorial freedom. That he is no ornamentist I am quite sure. He invented, so far as I can see, no detail of ornament. The details of the decoration of the Loggie—such as you see on the screen, the big scroll to the left, for example—are sometimes so directly taken from old work, that if a fragment of it, in sufficiently decayed condition, were to be placed in the Museum at Naples, it would take an expert to tell, at first sight, that it had not been dug up at Pompeii. The main difference is, that the newer painting is much more highly finished. Neither is there great invention or feeling for the ornamental shown in the more naturalistic foliation associated with the scrollwork—as in the smaller pilaster above the wave border—it is distinctly too natural in treatment for the ornamental function it pretends to fulfil. As for the birds and other creatures introduced, they are studies from nature, not in any way adapted to a decorative, to say nothing of an ornamental purpose. All the faults and inconsistencies of the old work, the

balancing of heavy bodies on lines inadequate to their support, and so on, are faithfully, and as if lovingly, copied; it is, in short, not so much design as reproduction. The merit of the work, as decoration, consists almost wholly in its arrangement and setting-out, in the balance of colour, in the proportioning of dark spaces to light—as in the little dado panel below the floral pilaster, where the ground is alternately light and dark—in the distribution of the ornament in short, in respect to which I am very ready to admit that the ornamentist is quite likely to be inferior to the great painter, and may well be content to sit at his feet.

There are some fine doors in the Vatican which are attributed to Raffaelle, and it is likely that he did give some notion for them; but any one who knows the work of Giovanni Barili knows that the woodcarver was himself a master; and will feel that, though he may have brooked the direction of the painter, there was no occasion for it, and that he did his best work when he worked out his own thought—as who does not? The specimens of Barili's work on the screen are now at the Academia at Siena—they don't show him quite at his best (it is, unfortunately, not always possible to illustrate the things one would like to show), but they are enough to prove that he was quite fit to run alone, and wanted no leading strings, which must have been rather a hindrance than a help to a man of his character. The Barili Brothers finished the carving of the stalls at the Cathedral of Siena, and executed the superb sedilia there.

I may mention here another among the many whose glory is seen but dimly in the light of the greater reputation. The choir stalls in the Church of S. Pietro at Perugia are carved by Stefano Da Bergamo—there seems to be no doubt of that—but it has been felt necessary to find a more resounding name to father work so universally admired, and the design is accordingly set down to Raffaelle. Once more I say, the man who carved those stalls knew his trade, and was master of it; he wanted no painter, whoever he might be, to teach him to design. On the contrary, it seems to me that this man was the master of ornament, and could have taught the Roman school a lesson had they been modest enough to learn of him. It is rarely that one finds in the ornament of the Loggie such grace of line, such delicacy of detail, such simplicity of design, such reticence, such submission to the purpose of ornament, as in this comparatively unpretending work of the mere woodcarver.

The ornamentist *par excellence* of the school of Raffaelle was undoubtedly Giovanni da Udine (1489-1561), who inherited, it may be supposed, his instincts in the direction of ornament, for he came of a family so distinguished in the art of embroidery, that they lost their family name of De' Vanni, and came to be known as De' Ricamatori, or the embroiderers.

Giovanni was noted for his painting of birds, fruit, and foliage; and we may safely ascribe to him the better, if not the greater, part of the more naturalistic detail in the Loggie, the fault of which, as I have said, is that it is too naturalistic for the subordinate place it holds in the scheme of decoration. But he was most expert also in the more fanciful, not to say fantastic, style of ornament, which, from its having been founded upon the paintings discovered in the excavations or "grottoes," goes by the name of the grotesque, consisting, as you know, of arabesque ornament in combination with human figures, animals, chimeras, and the like.

In the hands of Da Udine the scroll took rather a characteristic form: it is attenuated to a degree out of all proportion to the substantiality of the figures growing out of it or perched upon it. It might fairly be called stalky, and it would be possible to find fault with the drawing of it sometimes, but it is always freely drawn—there is great charm in that—and with the touch of an artist; in fact, it has the crowning merit of spontaneity. There is a certain refinement of effect in these wiry arabesques, apart from the colour, which is very delicate against the white ground. That white ground, by the way, is as characteristic of Da Udine's work as the black ground is of his predecessors.

Of the admirable setting out of the decoration of the Loggie, the scheme of light and dark, the lines, the spacing, the distribution of the masses, I have already spoken. The precise part due in all this to Da Udine I do not pretend to determine. I only know that he had a masterly way of setting out a scheme; and if the design of his detail had only been equal to the ingenuity of its distribution, he would have been not only a master, but a great master of ornament. That simple panel of his on the screen is a masterpiece in its little way. It is one of those interludes in stucco with which he delighted to vary his painted decoration, and in which, whether at the Vatican or at the Villa Madama, he was always very happy, but it is not always he

s so happy as that. What charms you, generally, in his work is the *ensemble*; when you come to look into it, there is often so little real beauty in the detail that you wonder how you came to like it so. (I am not at all sure that the decoration of the Loggie ever looked better than it does now, in the semi-decayed condition in which we see it.)

If I confess to a certain impatience with the frivolity of that kind of art, I should add that mine is perhaps rather a personal than an artistic objection. It is impossible for any one with ornament in his soul to doubt that the man who did that panel was an ornamentist to his finger tips; and he knew his own strength, for he devoted himself, to the end of his days, to the work for which he was cut out.

It was otherwise with Giulio Romano, who eventually developed into the figure painter; and, I am inclined to think, though I do not pretend to say it was so, that, even in the days of his pupilage, it was mainly to the figure that he devoted himself. It would only be natural that the master should entrust such work to his favourite pupil.

I consider Giulio, then, rather a decorator than an ornamentist; a prodigiously clever one, but by no means to be trusted in the matter of taste. The ornament in the Palazzo del T is more or less effective, but is no more than there must have been plenty of young men about him quite capable of doing, to say nothing of Primaticcio, who is probably responsible for the delicate decoration of the little bath-rooms, somewhat removed from the main building.

At the best, there is no painted decoration at Mantua to bear comparison for a moment with the carved enrichment of the private apartments of Isabella d'Este (illustrated). One is not surprised to find that the name of this master is also unrecorded: he was merely a master of ornament.

In connection with Giulio Romano should be mentioned Giovanni Francesco Penni, il Fattore as he was called, who worked with him in the Sala di Costantino (1524-5), and Perino del Vaga, whom he introduced to Raffaelle, and who proved one of the most expert assistants of Da Udine, but who eventually blossomed out into a painter à la Romano.

One of the last of the school was Francesco Salviati—who, by the way, got his name from his patron, the Cardinal Salviati. He designed tapestries to be woven in arras, and painted a good deal of decoration at Florence (some in the Palazzo Vecchio if I am not mistaken)—all very much in the manner of Da Udine, only making more prominent use of the human figure, by which it did not greatly gain.

A great contrast to the painted decoration we have been discussing is afforded by the missals and choir-books of a rather earlier date. Italian illuminated books are often much less crude in colour than many of the Gothic illuminations one is called upon to admire. The choir-books at Siena are famous especially for the miniatures enclosed in the initial letters, some of which are remarkably fine; but I cannot bring myself to like their introduction into such a position. What interests me more than the miniatures is the ornament, which is not only drawn with a delicacy one might expect in association with such miniatures, but designed with an individuality all the artist's own, and treated with a breadth and largeness of style one certainly does not look for in work on this minute scale. It is by Giraloma de Cremona, I think.

One more specimen of carvers' work to illustrate what I take to be the general superiority of the carver to the painter in merely ornamental design, at this period. No one who has been to Verona can have failed to be struck by the carving and intarsia in the Church of S. Maria in Organo, of which a very delicate specimen is shown on the screen. There is none of the swagger of the artist-prince in that, but the loving devotion of the Frate. I do not mean to say that this is religious art. Fra Giovanni may have been a pious soul, or he may have sought the shelter of the church only to enable him to pursue his art in peace; but what is quite clear is that he was devoted to his work, glorying in it, and not caring greatly for the glory it might bring to him. It may have been the spirit of the monk in him, content to give the glory all to God; but it is, indeed, the spirit in which the best has always been done, and always will be, for the satisfaction of doing it—and there is no satisfaction in doing less than the very best it is in us to do.

Miscellaneous.

THE CHICAGO EXHIBITION.

The Foreign Office have published a report received from the British Consul at Chicago on the inauguration and condition of the Exhibition. Some particulars relating to the financial part of the undertaking are given.

The cost of the Exhibition (says the writer) may be judged from the moneys raised by the Commission, together with the funds appropriated by the national and foreign Governments and the different States of the Union for their separate buildings and administrative expenses. The total receipts and appropriations, in a condensed form, are as follows:—

Description.	Amount.	
	£	£
Receipts from stockholders	1,145,105	
City of Chicago	1,030,928	
Debenture bonds	844,227	
Gate receipts to April 1	48,423	
Interest	18,343	
Miscellaneous receipts	60,929	
Total receipts of Commission	——	3,147,955
Original appropriation of United States Government	309,278	
Appropriation of souvenir coins	515,464	
,, for medals and diplomas	21,237	
,, for National Commissioners and Boards	225,954	
Total National appropriations	——	1,071,933
Contributions by States of the Union	1,241,412	
Appropriations by foreign Governments	1,170,165	
Other sources	184,790	
Total State and foreign appropriations	——	2,596,367
Grand total	...	6,816,255

Of the amount contributed by the different States for their several buildings and expenses, Illinois raised £165,000, New York £123,710, California £113,400, and the other States varying but smaller sums. In some States additional appropriations have been made by the Legislative Assemblies, and in others, counties or towns have set apart funds for exhibits, or contributed building material, or entertainments have been given to increase the funds. Of foreign countries, Germany leads with an appropriation of about £165,000, and, it is stated, a further sum has been approved for German representation at the Fair; France follows with £151,135, Japan with £130,000, and Brazil with £124,000. Great Britain comes next with £60,000, followed by New South Wales with £50,170, Spain with £44,120, Guatemala with £41,240, Costa Rica and Morocco each with £31,000, Peru with £29,000, and Ecuador with £25,000. The Argentine Republic, Austria, Colombia, Canada, the Netherlands, Sweden, and Paraguay have appropriated about £20,000 each, and the other countries lesser sums.

Including the souvenir coins donated by the National Government, the total receipts of the Exhibition up to date (May 6) amount to £3,663,419, which about represents the sum expended by the Commission on the undertaking. The stocks and bonds amount to £1,989,332, to recover which large sum and the further current expenses in keeping the Exhibition open till the end of October the gate receipts are counted on in conjunction with receipts from the concessions, which are expected to bring in a large sum. There will also be something saved out of the buildings when they are pulled down or sold for removal, but whether the enterprise will be financially successful must be left for time to prove.

The Consul adds:—With wonderful energy an undertaking of vast magnitude has been realised. The World's Columbian Exposition at Chicago in 1893 is the most important Exhibition which has ever taken place, and its influence on the trade of nations may not be unimportant. The contest has now begun, and it is the aim of all to gain the position held by others; many channels of trade may be turned, and those who exert the most energy, and take the best measures to secure it, have the best chance of success; while, in proportion, as some gain, others must suffer. The United States will undoubtedly be a great gainer in many ways by the Exhibition; it will improve the taste and feeling for the higher arts, and raise the educational standard of the people, who will not be slow to profit by the lessons learnt; and as some of the finest work from all parts of the world will be on view, and each country is so well represented, a visit to the Exhibition will afford to the people of all nations an opportunity which should not fail to be a source of profit.

General Notes.

The Administration of the Chicago Exhibition.—Certain changes in the management of the Exhibition are reported from Chicago. All the committees and bureaus, except three—Executive, Finance, and Legislative—have been dispensed with, and their duties transferred to the Council of Administration, consisting of Messrs. Higinbotham (President) and Schwab, representing Chicago, and General St. Clair and Mr. Massey, of the National Commission. The effect of this rearrangement is said to be to strengthen the hands of Director-General Davis, and to make him the actual head of the Exhibition.

The Japan Society.—At the tenth ordinary meeting of this Society, to be held at 20, Hanover-square, on July 19, at 8.30 p.m., Mr. George Cawley (late Imperial Engineering College, Tokio) is to read a paper on "Wood and its Application to Japanese Artistic and Industrial Design." Mizutani, a *Daiku* (master carpenter and joiner) of Tokio, will give practical demonstrations of Japanese carpentry and joinery. The Japanese Section of the Cornwall County Fisheries Exhibition is being organised by a Committee of the Council of the Japan Society. Numerous exhibits, illustrating the fisheries of Japan, are now on their way to England, and many collectors of Japanese works of art have promised to lend objects representing fish and fishing.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Monday, July 17. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, Bart., K.C.B., D.C.L., D.Sc., F.R.S., William Anderson, D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Braddon, K.C.M.G., Sir Frederick Bramwell, Bart., D.C.L., F.R.S., G. Ledgard Bristow, Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Michael Carteighe, R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, Francis Cobb, Prof. James Dewar, M.A., LL.D., F.R.S., Major-General Sir John Donnelly, K.C.B., Sir Henry Doulton, James Dredge, Walter H. Harris, Charles Malcolm Kennedy, C.B., Sir Villiers Lister, K.C.M.G., John Biddulph Martin, John Fletcher Moulton, Q.C., F.R.S., John O'Connor, Florence O'Driscoll, M.P., W. B. Perceval, Prof. William Chandler Roberts-Austen, C.B., F.R.S., and Sir Owen Roberts, M.A., D.C.L., F.S.A.

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CANTOR LECTURES.

SOME MASTERS OF ORNAMENT.

By Lewis F. Day.

Lecture II.—Delivered April 17, 1893.

My last lecture dealt with the rise of the Renaissance in Italy. Renaissance art in France was at first, and for a while, Italian art. It is commonly supposed that its introduction into France was altogether the doing of Francis I.; but that is not precisely so. Already, during the reigns of Charles VIII. and Louis XII., the wars with Italy had brought the French into contact with it, and they had promptly caught the infection. The town of Lyons, again, was on the road to Italy, and in direct communication with Florence and Venice, where the Italian Renaissance was flourishing; ships from the Italian ports would be continually putting into French harbours; and so something of the influence crept, no doubt, imperceptibly across the frontier and round the coast.

Accordingly, we find, even before its encouragement by Francis, a certain amount of Renaissance art in France, although of a quiet and unassuming kind, as became an art not yet in fashion.

But it is quite true that to Francis is due the impetus of the revival, and it is not without reason that he is called "Roi de la Renaissance." It was the fashion in those days for princes to honour artists; Francis loved them. He would have made France of the Valois equal in artistic renown to Florence of the Medici; and even of his successors it must be owned that, unequal as they may have been to the function of king, the Valois were as a rule worthy patrons of art.

Every one knows how Francis, to satisfy his perpetual craving for embellishment (whether of his famous châteaux, or for the temporary *fêtes* in which he delighted) imported into France Italian artists (Serlio, Rosso, Primaticio, and the rest) of more or less note in their own country, but their work is in no wise French. They worked, naturally, in the manner to which they were born. Side by side with them the native Frenchman went on working at first in his own mediæval way. But soon the spell of the idea began to work upon him; and he ended in forsaking his old love, enamoured only of the new forms. It was in endeavouring in all *naïveté* to imitate them, that he developed quite unconsciously a new manner of his own—the style François Ier—which is thus due to the indigenous craftsmen, whose mediæval personality is disguised, but not quite hidden, by the elegance of the foreign garb.

But whilst endeavouring to imitate Italian forms, so far as they pleased him, he had yet no notion of being enslaved by them. It never occurs to him that he is not at liberty to modify them to his heart's content, to play variations upon them as may seem good to him. It is not so much the classic leafage, for example, which he seeks to copy, as the living grace of its growth, the delicate curve of the scroll, the

balance of the ornament, its new-found beauty in short—it is that which takes his fancy captive, and fires his emulation. It is clear too, of course, that it would be his best policy, as well, to acquire the new manner, his only chance of obtaining a share of Royal patronage. And so, in the sunshine of Royal favour, the new style throve. It was not native to the land, but only transplanted into French soil, where for a while it was cultivated side by side with the indigenous Gothic growth.

But it was inevitable that the full-blown flowers of either kind should be inoculated eventually with the pollen of the other, multitudinous busy workmen performing the fertilising function of the bees; and so was propagated a hybrid growth, which grew up into a distinct order of art, distinguishable as French Renaissance, the earliest variety of which is known as the style of François Ier, a style which, if it never quite provokes our enthusiasm, charms us always by its gaiety; a style which is seldom expressive of any grave or lofty thought, if even capable of such expression, but full of life and liveliness, a winning smile, so to speak, on the stern face of architecture.

It has been laid to the charge of the French king that he is responsible for the extermination of Gothic art. That is absurd. Living art is not so easily killed by any man, even though he be king. The utmost he did was to hasten on events. The truth is that the thread of Gothic tradition, weakened by the wear of three or four centuries or more, was already stretched to the utmost limits of tension; it was ready to snap at any moment, when Francis came to the throne; but so far from its being true to say that he severed it, it might more fairly be averred that it was he who provided from afar, not only the strands of newer and stronger fibre, but the deft workmen to weave them into it—strengthening, for the time, and even preserving, the life of mediæval art, at the cost eventually, no doubt, of its identity.

The names of the first native workers in the new style are as obscure as though they had gone on in the traditional Gothic manner. I can show you instances of François Ier ornament, which will give you an idea of the style, and illustrate, I hope, what I have been saying, but I cannot tell you always who did it. The example on the screen is from the choir stalls of St. Denis. You will see in the central panel a marked rigidity of line, bespeaking the carver trained in the severer Gothic manner. He appreciates already the grace of the Italian arabesque, and arrives himself, in his design, at a degree of elegance quite foreign to mediæval tradition; but there is a distinct staidness about it. He is constrained in his new habit, and lacks the ease of the Italian to the manner born, from whose hand the curves flow freely and spontaneously, as though it must be so, and he could not do otherwise. This man, I say, arrives at grace of line, but it is pretty clear that he sought it; it did not come to him naturally.

That wall-panelling is from the Château of Blois, from "the workroom," as it is called, of Catherine de Medici. The framing of the panels is of the severe simplicity one would expect to find rather in late Gothic woodwork than in Italian; and there is about the carving itself—although it would fain be Italian—a native *naïveté* of composition, which betrays, without a doubt, the hand of a French workman.

The carved panel, from the door-screen at the Hôtel de Ville at Oudenarde (by Paul von Schelden, 1530) is more nearly Italian; but you will never find in Italian work quite the same treatment of foliage; there is a certain square blocking-out of the leaves apparent for all the bold relief of the carving which is distinctly Gothic. (Oudenarde, of course, is just over the frontier, but there is nothing Flemish about that work; it is plainly French, and François Ier.)

The pilasters from the famous rood-screen at Limoges are still more full and florid, but they, too, are distinctly French. There was, it must be remembered, a very florid development of the Gothic style in France, appropriately styled the "Flamboyant." No one at all familiar with the French and Italian styles would ever mistake this for Italian work.

One begins to realise here how frankly pagan is Renaissance art, even when it is destined, as in this case it is, for a church, and how essentially the nude figure is part of it, even in situations where its most devout admirers could scarcely call it appropriate. But, appropriate or not, those are very charming figures, and disposed with the instinct of an ornamentist.

In the case of the south door of the Cathedral of Beauvais, of which two panels are shown, the name of the author happens again to be known—one Jean le Pot—but that is all I know about him. The design of these panels is, I was going to say, exceptionally

elegant; but elegance is by no means exceptional in ornament of Francis's time—rather, it might be called characteristic of it. That mask in the left-hand panel is grotesque in itself and disproportionate to its place in the panel; but, for the rest, the arabesque is charming; and the manner in which it dwindles away towards the lower part of the door, and leaves the panel plain when you do not want ornament, is an instance of restraint such as one finds only in the earlier years of the Renaissance. Even the Renaissance was, in its youth, comparatively innocent!

You have only to compare that with the work of Primaticio, and you will see how essentially his design is, by comparison, Italian. There is no trace of Gothic in the tapestry illustrated on the screen. It belongs plainly to the school of Raffaelle. Primaticio, you know, was at work at Mantua, under Giulio Romano, for some six years, and was already forty years of age when Francis first summoned him to France, so that he had by that time formed his style, and was not likely to be much influenced by the work of native craftsmen, who, besides, were, of course, all subject to his authority.

It takes a modest man to learn of his subordinates, and modesty was not among the failings of Primaticio, to whom we may largely attribute—together with many of the merits of that brilliant group of designers known as the school of Fontainebleau—some of its demerits, especially that indulgence in pronounced relief, which is one of its least satisfactory features, and which, by the way, came out of the use of stucco, a material he had learnt to employ under Giulio Romano.

I attribute the greater importance to Primaticio because although Rosso, the painter, came to France a year or more before him, the former survived Rosso by many years, and at the death of that painter returned from Italy (where he was collecting antiques for the King) and continued to work on at Fontainebleau during the reign of Henri II. and into that of his successor. He, therefore, best represents the school of Fontainebleau—essentially an Italian school, brilliantly clever, but not, as I have hinted, by any means reticent or retiring, and so far from hiding its light under a bushel, that it lays itself perpetually open to the reproach of asserting itself unduly; it is nothing if not declamatory.

As regards Sebastian Serlio, architect to the King, and, of course, a man of great importance and considerable influence upon design, he published an important work on architecture (not unworthy of the pupil of Peruzzi) which contains some good examples of decoration—but I am not aware that he distinguished himself especially by the design of anything very noticeable in the way of ornament. He had probably more important work to do than to attend much to ornamental detail.

Among Italian sculptors who greatly influenced French art and French ornament were the brothers Just—Jean and Antoine—natives of Florence (for all their French-sounding name) who established themselves at Tours, and who did much of that excellent work which we find in Normandy and in the châteaux along the Loire. But it is out of the question always to identify it. It is so long since, and the years fall like rain. Drop by drop they blur and wipe out every trace of the steps by which it might once have been possible to track the secrets of the past.

Possibly the best-known of the French king's foreign *protégés* was Benvenuto Cellini, who lives for ever in the pages of his own picturesque memoirs. The man he presents to us is not, perhaps, so much the real Cellini, as what Oliver Wendell Holmes would call Cellini's Cellini, the man he would have us think he was. Even if the picture is exaggerated, it still goes to show how much the man was given to extravagance. It is pretty clear that, whatever his virtues, he pushed them to extremes, and that he had the defects of them also. Clever he was, prodigiously, but more than appreciative of his own ability; versatile, but without steadfastness; daring to recklessness; full of vitality and energy, under no sort of control; not merely self-reliant, as an artist should be, but boastful to the point of braggadocio.

And something of all this one may detect in his art — in his sculpture, perhaps, but it is not with that that we are concerned just now. His sculpture may be all his admirers claim it to be. Of its technical merits I suppose there is no doubt at all. It is with his ornament that we have to do, and that, for all his fame, for all his training in that best of schools, the workshop, is so little sober, serious, or restrained, that one hesitates to call it ornament at all. He knew, indeed, how to mount jewels to advantage, and he could chase marvellous little figures in gold and silver, but his art consists very much in that, and seems to end there. His jewellery is wonderful in its way, but the effect produced

is never proportionate to the artistic effort expended upon it.

In his more important ornamental compositions, if we are to attribute the Turin shield to him, the details are too obviously put together. It is very much a hotch-potch of figures and strapwork and so on.

As to the well-known salt cellar, which is certainly his (with the lady and gentleman in undress sitting on opposite edges of an over-elaborated bath) it is simply preposterous, and his evident pride in it shows conclusively that he had not even the rudimentary sense of fitness, without which a man can hardly be an ornamentist.

At Fontainebleau, it happens again, that, so far as ornament is concerned, the carver is more tasteful than the painter. While Primaticio was declaiming in paint and stucco on the upper walls of the Salle François Ier, Siebecq (who may not have been a Frenchman, but was surely not an Italian) was expressing himself, in the panels of the woodwork below, with just sufficient emphasis of ornament. Only every other panel was as rich as that on the screen; the alternate panels were comparatively plain, with only enrichment enough to show that they had not been neglected, that it was not from motives of economy that the carver stayed his hand, but for the sake of simplicity and breadth. As it is, the work is rich, but none too rich for a king's palace.

There is dignity in the ornament, too, owing, largely, to the broad treatment of the central lozenge, with the badge of the king and the flat *cartouche* framing it, and of the smaller inscription tablets above and below, which keep it in countenance. These quiet spaces are perfectly proportioned one to another, and contrast very cleverly with the more broken surface of the scroll-work, and of the loose festoon of fruit.

The classic source of inspiration is here more plainly shown than usual. There is even a reminiscence of the familiar ox skull, so obnoxious to Mr. Ruskin, in the very conventionally-rendered skull of an antelope, whose horns pierce the lower part of the *cartouche*—inappropriate enough as a symbol, but gracefully designed, as the whole panel is.

One would, perhaps, have been disposed to think more highly of Jean Cousin, if his praises had been less aggressively sounded. To call him the Michael Angelo of the French is to court contradiction. He was distinctly an able all-round man, equal to the many claims made in those days upon the versatility of an artist. Architecture and sculpture were not enough for him. He designed, also, for stained glass, among other things; and if only half the windows put down to him are his, he must have devoted to it great part of his very considerable abilities. But it is as a designer for book decoration that he is best known. The title-page shown is a favourable example of his manner, executed probably in his later years, for it appears to have been published after his death. He died only in 1589, and brings us, therefore, really to a period not yet under discussion; but as he was born in the very first year of the century, it would be awkward to postpone mention of him.

He was like Michael Angelo in that, at least, that he cared more for the human figure than for ornament, and that he used for ornament mainly architectural forms. It is seldom that he indulges in anything in the way of scroll, arabesque, or foliated ornament. He delights in the combination of nude figures with the *cartouche*, which plays, by-and-by, an important part in the development of ornamental design. In the last two illustrations shown, there occurred already the *cartouche*, but here the *cartouche* is the design, or, at least, the framework of the design.

Among the school of Fontainebleau must be reckoned Jacques Androuet du Cerceau, as he was called, from the ring or hoop, which was the sign of the house where he lived, or, as some say, the sign of his father's wine shop. He owed something, no doubt, to Primaticio and Rosso, whose work he studied, but the school also owed something to him. There is a restraint about his ceiling in the Salle Henri II. at Fontainebleau (to which I shall have occasion to refer later on) which the Italians would not have exercised.

Du Cerceau was an adept in the manipulation of the current style, neither quite Italian nor quite French. He did nothing very ambitious, but much that was very graceful, especially in the way of arabesque. He is extremely well known from his engraved work. He was not, like De l'Orme, an architect who published merely the results of his individual study and practice, but an architect who took to engraving. On his return from Italy, he opened a studio, and published not only his own designs, but those of others, collections of designs in fact. How far in rendering them he made them his own, is a question.

Of his "grotesques," for example, he only

claims part of the merit; and one of the two panels shown is certainly taken bodily from a print by the Italian Agostino Veneziano, a pupil of Marc Antonio, who may himself very possibly be only the engraver of the plate.

Du Cerceau designed wholesale for the French *ateliers*, and, by the multitude of his published engravings (some 1,300 and more) which were everywhere copied, as he meant them to be, he did something towards the effacement of individual and local characteristics, and the spread of a more uniform style of design, which became in the end monotonous.

He was not so much an architect, one is led to believe, as a designer of architectural detail and ornament; not so much a designer as an engraver; not so much an engraver, perhaps, as a publisher; but, all the same, he really was an artist, and an ornamentist. His designs for furniture, if not always so happy as his arabesques, are more original, more distinctly his own. In the course of a long life, his style underwent changes. He lived almost to the end of the Valois dynasty; and the pronounced style of Henri II. owes something to him, no doubt. But of that, also, I shall have more to say in my next lecture.

With Du Cerceau must be mentioned Etienne Delaulne, who signed himself Stephanus; for Du Cerceau passes for a disciple of his. He was a goldsmith, and his work was essentially designed for its purpose. His style was a French version of the Italian; his design was a little bit worried at times, but it was ingenious. He could be fanciful, and yet keep within bounds. His work is elegant, even when it is capricious, restrained, even when it is most rich. The designs of Stephanus were copied by Pierre Raymond, the enameller, amongst others.

The famous enamellers, by the way, from Leonard (the Limousin) downward, Penicaud, Raymond, Jean Courtois, were all of them admirable craftsmen, painters rather than designers. Not one of them showed much originality. They were content to take a print or picture by Rosso, Primaticio, or another, and play variations upon it. It cannot be said that any one of them is an ornamentist.

Neither does ornament owe anything to Bernard Palissy. "He expresses," says a French critic, "what is most original and characteristic in French art." That is rather hard on French art. The ornamental career of Palissy was from bad to worse. The medallions and suchlike reliefs, glazed with white enamel, with which he began, may pass. Not so the cups, goblets, and dishes, which, in the second stage of his development, he marbled over with variegated glaze: the effect of that was simply nasty. As for the rusticities in earthenware, which mark the crowning point of his popularity, where lizards, snakes, frogs, eels, and suchlike slimy and uncomfortable creatures are modelled to the life, on dishes roughened to look like mother earth, and further encumbered with shells and what not in the way of incrustation, nothing could well be more unpleasant in effect, or more unpardonable in taste. The form of this famous ware indicates plainly that it was meant not for use but for ornament: it appeals to the eye, and the eye will have none of it: the sense of beauty, to say nothing of propriety and restraint, sickens at the sight of it. It does not even attain the vulgar end of realism at which it aims. Whatever effect of reality might have been produced by the very clever modelling of the creatures is destroyed by the absolute unreality of the unbeautiful colour and the horrible sliminess of the glaze. It is rather sad to reflect that the very quality which we most admire in the man was probably at the root of his artistic inadequacy; the very stubbornness of his nature prevented his learning except in his own dogged and devoted but more or less blundering way. Lacking unfortunately the advantages of education he had everything to learn so far as taste was concerned, and never learnt anything. All praise to his industry and perseverance! Grant him technique, and, so far as modelling is concerned, art. His book is a tribute to the dignity of endeavour, but as for ornament, he had not the remotest perception what it was.

With Jean Goujon we come back at once to sculpture and good taste. He is not directly responsible, that we know of, for any great amount of ornament, but there is evidence enough of his influence upon the ornament of his time, if only in the delicacy of relief which became the fashion, especially in wood-carving, for it was he who first showed to the French the decorative value of low relief.

Of the dignified grace which is so characteristic of his figures, or even of the decorative instinct with which they are disposed within architectural lines, we have not now to do; but if the style of Henri II. is more refined than that of François I^er^, it is in some degree owing to Jean Goujon.

In the cabinet upon the screen you see not Jean Goujon but his influence, which may be traced in the delicacy of the carving, sometimes in such very slight relief that it might almost be called engraving.

French art, however, under the later Valois was influenced, to some extent, by the published works of the German artists known by the name of the "Little Masters;" and before discussing it further, it will be as well to go back and see what they had been doing.

The Renaissance in Italy was the outcome of learning, a beginning of the scientific spirit. It meant a general seeking after culture. The people were interested in it, as they were in art, and so Renaissance art grew.

In France, as I have said, it was the king that introduced both the art and the artists proficient in it; who went on working in the new country in the manner native to them, until Frenchmen took a liking to it, or found that their best chance of patronage was to work as much as posible in the new manner.

In Germany, it was the artists who initiated the movement. South Germany was still more intimately connected with Italy than France was. Augsburg and Nuremberg (the headquarters of German art in the early 16th century) were in close commercial relations with the Italian cities. The Germans are naturally wanderers: swarms of German students went to the famous humanistic universities of Padua and Bologna; and Venice was not so far off but that apprentices, who had served their time, and had to pass their *wanderjahr* before they could settle down and call themselves masters, often found their way there across the Alps, and came back in love with the beauty of Renaissance art; for it must be confessed their own Gothic art was inclined to be over serious and severe—too strictly bound in the service of the Church; and the idea that beauty was in itself an end worth seeking, was a revelation to them, and they were fascinated by it.

Art in those days was entirely in the hands of the artisan—happily. There was no distinguished class of fine artists; and something of the homeliness of the people shows itself always in early 16th century art. The only potentate who in any direct way patronised it, and that mainly in the commissioning of the famous woodcuts, was the Emperor Maximilian. We find, accordingly, not, as in France, a vast number of important monuments, palaces, châteaux, and what not, but a multitude of less pretentious and more popular productions. The masterpieces, for example, of Adam Krafft and Peter Vischer were produced at the instigation of the citizens of Nuremberg; and, whilst in England, it was King Henry who was the patron of Holbein, the Darmstadt Madonna was a commission from the Mayor. It was really something like art by the people for the people. And the people were always German.

The very earliest French Renaissance art flattered itself, perhaps, that it was as nearly as possible Italian. Early German work has no idea of ceasing to be German, or, if ever it had, it failed conspicuously. The acanthus leaf in German hands ceases to be acanthus, and takes much more the shape of crinkled cabbage; the vine leaf, borrowed from quattro-cento carving, grows with more vigour and less grace on this side of the Alps. The Gothic spirit is, in short, ingrained in the German. Gothic traditions cling to him. Side by side with arabesque detail, we find in his work Gothic canopies and other architectural framework; and the Gothic feeling never quite dies out of German art. The artist may have been ever so much in love with Italian forms, he may have masqueraded in Italian dress, but he can hardly have persuaded himself that his nationality was ever disguised. There was no mistaking the sturdy German build.

I can show you a specimen or two of Gothic work. Schöngauer, or Martin Schön as he also signed himself, appears to have been quite uninfluenced by the coming style—he died, indeed, just before the birth of the new century, but his Gothic was of the most florid type. He delighted in that luxurious kind of foliation which was so characteristic of the full-blown German Gothic. There is a panel of his, forming one of a series of designs he made for goldsmiths' work, in which we find, not only the familiar crinkled cabbage leaf, but also, by way of central flower, a splendidly conventionalised cabbage head, on a stalk which has something of the ruggedness of the veritable vegetable. That, as far as my experience goes, is not a usual form of ornament at all.

Schöngauer leans sometimes distinctly too much to the side of rusticity; but, though his work was always rich, it was not always loose. He curled his leaves about, but he could curl them into the shapes he wanted. He came of a family of goldsmiths, and knew how to conform, as the censer on the screen shows, to the conditions of the goldsmiths' craft. That,

I think, is a very splendid example of his design. When you have said that it is florid, you have said, it seems to me, the utmost that is to be said against it.

Dürer, in his *wanderjahr*, in 1492, was in Colmar, where Schöngauer lived and died, and was very likely influenced, to some extent, by the sight of his work.

Another Gothic ornamentist certainly was influenced by him, for an engraving of this very censer by his hand remains to prove the fact. That was Israel Van Mecken, or Van Meckenen, a native of Mechlin, who worked the greater part of his life in Westphalia. He was an engraver as well as a goldsmith; but, as you know, engraving, in its beginnings, had no place as an independent art. Critics generally —caring nothing for ornament—speak slightingly of Van Meckenen, who was undoubtedly a master of ornament, and no mean one. He founded himself very much upon Schöngauer, but he evolved a manner quite his own. He rendered the Gothic scroll about as well as it was possible to do it, and, in every case, he was at the pains (if it was any pains to him) to invent his foliage and floral details: they never by any chance turn out to be old friends. The human figures he introduced into his compositions may not be very learnedly drawn, but they are at least vigorous and characteristic, and, what is most to our purpose, they fulfil invariably their ornamental function to perfection. They are, moreover, conventional enough (as for that matter, all figure-work was, happily) not to clash with the ornament at all, but only to give it emphasis.

Van Meckenen's scroll, I said, is invariably admirable. The one respect in which it occasionally transgresses is, that we find sometimes in it a comparatively natural stalk, which obviously does not by right belong to the conventional foliage with which it is associated.

There is no such fault to find with the splendid panel before you. The design consists, as you will see, of the artist's own name, Israel, and then, sideways, the letter M. The cunning with which the letters are hidden away in the midst of their own foliage, and only reveal themselves by degrees as you look for them, is something to marvel at. It does not strike you all at once what the letters are; it takes you a little while to perceive that they are letters. You are conscious, at first, only of a labyrinth of splendidly vigorous and graceful ornamental growth, in which, by degrees, it dawns upon you that there is a meaning.

Van Meckenen was an adept in the art of hiding—and yet not quite hiding. In some of his initial letters, which I am sorry I cannot also illustrate, the thickness of the Gothic capital is filled with scroll-work, and the background again with other scroll-work, and yet there is never any confusion, only a pleasing mystery of effect; they are readable and unmistakable initials always. Van Meckenen, in short, was a master.

One other Gothic workman, a sculptor this time—Georg Syrlin. There is little to be learnt concerning him, except that, with his sons, he carved the stalls of the cathedral at Ulm, one panel of which is illustrated. He was no better than some other Gothic carvers, perhaps, but we happen to know his name, and, anyway, he was a master of ready, bold, and masculine ornament. In some other details of his work he takes, perhaps, undue liberties with nature—that is to say, the details are rather too much like nature, or the growth too little like it, but there is no such fault to find here. I do not know what he means it for—if he meant it for anything—and I do not care. I only know it is fine ornament.

Among the men of whose works I am sorry not to be able to show you examples is Adam Krafft, the stonecarver. Most of his work is at Nuremberg, notably the *sacraments-häuschen* in the Lorenz Kirche, finished in the year 1500, and still quite Gothic. Krafft, it is said, worked equally with both hands; with whichever hand he did it his detail is always sharp and crisp, and may even be accused of a certain German hardness; but it is masterly work always.

Both he and that other famous sculptor, Virt Stoss, clung more closely to tradition than their fellow-townsman, Peter Vischer, the bronzeworker. His famous shrine of St. Sebald (there is a cast of it at South Kensington Museum) is a wonderful medley of Gothic and Renaissance, in which there is yet no discord. The scheme of the tomb is Gothic, its main lines are Gothic, the shafts of the columns and the arches are Gothic, but the bases of the columns are Renaissance, the candelabra-like features, which recall the façade of the Certosa at Pavia, are Renaissance, and so is all the ornament.

Peter Vischer learnt his trade of his father, who was a working founder, and he claims himself to be no more than the founder of the famous shrine. Yet, though Virt Stoss and others may have designed the figures, the ornament is pretty certainly his. He had

made two journeys to Italy, which would account for his adoption of the new manner, in which he appears to have been first and foremost among plastic workers of his time.

Daniel Hopfer again illustrates the transition. There were two or three Hopfers, but Daniel was the most important of the family. He was an engraver and goldsmith of Augsburg, son of a painter, who had settled there quite at the end of the 15th century. The scroll I show is still Gothic, you see, but no longer quite uninfluenced by Renaissance arabesque; There is a suavity about the lines which prepares us for the going over to the new school. In the panel to the right Hopfer has deliberately gone over. The detail there is about as Italian as German work can be; but still one sees the German in it. The Hopfers were undoubtedly influenced by Mantegna: one of them engraved some of his designs. There remains to be mentioned the diapering of the ground behind the letters of the alphabet, which is delightfully free and fanciful. That kind of thing must have been done spontaneously, and the man who could do it had ornament at his finger tips.

Hans Burgkmair, again, I refrain from illustrating only because I cannot illustrate every one, and he is, perhaps, well enough known. He was quite one of the most important of the Augsburgers, a pupil of his father, and a friend of Dürer, in association with whom he worked upon the famous Triumph of Maximilian, by which he is best known. He is one of those who in the most naïve way mixed together in his design florid Gothic and rich Renaissance detail. You see the two conflicting influences of tradition and impulse at work in the man, and seem, somehow, so to get nearer to him. Already at the beginning of the century his work shows traces of Italian influence, but after his sojourn in Venice (1508) it is still more marked. His work is more remarkable for strength and downrightness, than for anything like ideal beauty, but especially in that heraldic form of design in which his countrymen are always at their best he is distinctly a master.

We come now to a great name, Dürer. Dürer was essentially of the transition; he went more than once to Italy, although, as he gives us himself to understand, his visit to Venice was more with the idea of showing the Italians what Germans could do than of himself seeking inspiration at a foreign source. For all that, the influence of Italian art is thenceforth very visible in his work, although he was too sure of himself to go over deliberately and entirely to the Italian manner. In his most Renaissance designs Gothic canopy work is apt to find its way—his very acanthus is grown in Germany.

He was essentially German; his work is apt to be rude, knotty, bunchy, seriously fantastic, worried more or less, unbeautiful; he had no promptings in the direction of suave and graceful form. It was a characteristically Teutonic trait in him that he was a believer in geometric proportion, and would have had us construct even the letters of the alphabet on intricate geometric lines.

Dürer was of the naturalistic school. "All art," he contended, "was in nature: the artist had only, as it were, to dig it out of her," which was well enough; but he went on to say, that the nearer the artist kept to nature the better for his art, using the time-honoured argument (shall I call it?) that God has done better than we can ever do, which, again, is very true, but it does not help in the least towards ornament. One is, therefore, not surprised to see that comparatively naturalistic foliage often finds its way into his ornament. One of the best examples of it is given in the grape-vine on the screen: it is florid and picturesque, but yet in a way ornamental.

But Dürer had not really any bias towards ornament. He did not in his heart care enough about Renaissance forms either to copy them correctly or to make them his own. Perhaps like Michael Angelo he also was of too serious a temperament to care for the jocund art of ornament. He seems to me, at all events, out of his element in it. His inclination is towards rusticity; but some of his work is more than rustic; it forestalls the rococo! The screen contains a specimen of Dürer's penmanship; the letters are good—he could write—but the ornament is mere flourishing, and not beautiful at that. The famous book of Hours which he decorated for Maximilian was still less reposeful. It combines the conventions of the writing-master with the looseness of the painter. Compared with the mediæval illuminations, with which it courts comparison, his flourishings are mere artistic antics.

Dürer comes nearest to being an ornamentist in the professional car which forms part of the famous "Triumph;" and in his heraldry, of which two splendid specimens are shown. Here we have the work of an undoubted master; but lest it should seem to belie what I have been saying, I must remark that any

German of his day who could draw could draw heraldry, and draw it admirably (there is no particular invention shown there in the way of ornamental design) and that the merit, the extraordinary merit, of these designs consists in the composition, and treatment, and drawing of forms which were pretty well common property, in the qualities which go to make a great draughtsman or painter, but which do not constitute him an ornamentist.

Hans Holbein, now, had the sense of ornament, and his early training in design for goldsmiths' work developed it. Holbein the elder, the father, worked on always in the old way, and it was Burgkmair who introduced the new manner to the younger Hans; and he was really the first to break entirely with old traditions and adopt the coming style. A mediæval cast of thought is apparent, of course, in his famous "Dance of Death," but it is seldom that we find in his compositions any lingering detail of mediæval ornament. He no longer played with Renaissance forms, as some had done; he is penetrated by the modern spirit; and he really is of the new generation.

It must be confessed, I am afraid, that he was as ready as any Italian painter to take a house-front for his canvas and paint it, as little restrained by any care for strictly architectural proprieties, and that if he saw a chance of converting a mean building into a work of what may be called scenic decoration, he would seize upon the opportunity, and turn it to such artistic account as to win the admiration of all but the most strictly and architecturally orthodox. In his designs for goldsmiths' work, he seldom, however, makes much claim on our indulgence. He shows, on the contrary, uncommon self-restraint in his ornament, and remarkable ability. What little he did in the way of mere pattern-work is characteristic, if not original; but it is when he is dealing with the figure, of course, that he is happiest: then he is really himself. The noticeable thing about his design is that the figures are not introduced into the ornament; they are the ornament. In Holbein's case, as in Signorelli's, you feel that it was the lines of the composition that suggested the figure, and not the figure which compelled the composition. It is obvious that the ornament was designed within the lines of the sword-guard, pommel, or whatever it might be: the figures are compactly grouped within well-shaped general lines, and are, as I said, not merely ornamental, but ornament. The cup designed for Jane Seymour is a masterpiece. The outline of the cup itself, perhaps, is a little hard, but the rest—the cover in particular—is splendid work.

Holbein was realist enough in his way, but he was not satisfied with realism nor attracted by it. On the other hand, he does not seem to bother himself much about meaning in ornament. He has the true instinct of the designer; he is satisfied if his design answer its decorative purpose. His highest aim is beauty, and he often reaches it.

Perhaps nearest to Holbein in his manner comes Pierre Woeriot, of Lorraine (1532). The sword-hilt on the screen—quite one of his best designs—shows considerable grace of line, but, if you examine the female figure on the left-hand side, you will better understand, by comparison, how masterly Holbein's treatment of the figure was. Not only is the transition from figure to ornament awkward here, but the figure is too much an independent figure, and not part of the guard. The thinness of the neck, for example, suggests a weak spot at once. Yet this is much better than the average even of good work of the kind. The fact is, it takes a consummate master to make figure-work really ornamental.

Look once again at Holbein's sword and dagger decoration and see how fit it is, how compactly it is built, how restrained it is by comparison. There is no weak spot here; no point where you could say the figure ends and the ornament begins. The ornament is not added to the construction. Figure and construction are one and indivisible.

I must not forget Hans Mielich, or Muelich, the Munich master, who may be considered as a successor to Holbein, and who made excellent ornamental use of the figure. He designed a famous suit of armour for Francis I. The illustrations on the screen represent the kind of thing, but they hardly represent it fairly. The figures, for example, in the piece to the left of the screen, are meant to be embossed, and in execution they would assert themselves more than the plain bands, which first attract attention in the drawing; but designers will see how cleverly the figures are composed into the spaces they occupy. The design to the right reminds me of my friend, Mr. Crane, than whom no living man knows better how to render the figure ornamentally.

It remains to mention some of Albrecht Dürer's followers. Living as he did all his life at Nuremberg, his influence upon the im-

portant group of artists, of which he was the centre, was enormous. Altdorfer, Hans Sebald Beham, George Penez, and Aldegrever were among his pupils.

I give no illustration of the work of Albrecht Altdorfer, because I hardly think his work equal to his reputation. He is best known by a series of designs for cups or goblets, but they are not so good as some printers' ornaments of his, which are more in the manner of Aldegrever.

Hans Sebald Beham, though he had an uncle of some repute as an engraver, was distinctly of the school of Dürer. He designed a number of book-ornaments for Egenolph, the Frankfort printer, and, in the course of a rather reckless life, all sorts of things; but much of his work is pure figure work. His ornament relies very much upon the figure for its interest, and as his figures were good and beautifully engraved, his fame explains itself. No wonder he takes rank as the foremost of the Little Masters. He and his fellow pupil, George Penez, or Penz, were both born, curiously enough, in the year 1500, and both died in 1550, living just half through the century.

Lucas van Leyden is one of the only two Dutchmen who are known to have engraved ornament before the 16th century; the other was Dirk van Staren. It is hardly necessary to say that the author of that lower panel on the screen relied also very much upon the help of figure-work in his design, but some of his scroll-work is good. That panel reminds one rather of Dürer, as the scroll above reminds one of Aldegrever: at other times Van Leyden's ornament has very much the character of heraldic mantling. He could draw ornament; and the panel I show is cleverly composed; but there is something distinctly unpleasant about the pronounced she-monsters, which occupy so important a place in it.

The ornamentist *par excellence* among the Little Masters was Heinrich Aldegrever. His figure-work was possibly inferior to that of some of his contemporaries; but he did not greatly rely upon it, and in ornament no one of them was equal to him. As an engraver, too, he came very near to perfection; cleaner work it is impossible to imagine. Some 300 or more of his designs are known, and we are able to trace by them the development of his style. His earlier work illustrates very plainly what I said awhile ago about the foundation of German ornament upon Venetian quattro-cento work. There is no possible doubt as to the source whence the leafage in the panel to the left of the screen is derived, but, for all that, it is very far indeed from Italian. Aldegrever has made it entirely his own; it grows with a vigour quite unknown to the quattro-cento. The straight growth of the main stalk—a new shoot from the old stem—is full of life and elasticity.

In the earlier work of the artist, as in this panel and the two smaller ones, the figures he introduces, cousins german of the Italian *putti* mostly, are always separate from the ornament, and very often (as is here the case) they support it.

In his later work they grow out of it, or it grows out of them, in the regular Renaissance fashion. In the panel to the right, as it happens, there is nothing in the way of figure but a foliated face or mask. The design of this later and more orthodox scroll-work is not less excellent than his earlier and more individual performance, but it is less interesting. Character goes for a good deal in design. The variety of Aldegrever's invention was considerable. He had a delicate appreciation of graceful line, rare among his countrymen; he was never rude or rustic, as many of them were; in short, he was an artist in ornament, and a master of it, if ever there was one.

The list of the Little Masters is by no means exhausted. I shall have to allude to several more of them in my next lecture; but we have arrived, with Aldegrever and the middle of the 16th century (the latest date on any of his work is 1553), at the end of the transition period. The Renaissance now reigns supreme—German, French, or Dutch, it may be, and indeed it is no longer in Italy that its most interesting development takes place; but we have done once and for all with Gothic forms.

You will observe that I have said nothing to you about England as yet. I may as well make a clean breast of it at once, and confess that I am not going to say anything about our fellow-countrymen at all. It would take a rather tall patriot, I think, and one who carried his patriotism into a region where patriotism has no place, to make out a very strong case in favour of that supremacy of English ornament, in which it might be pleasing to some of us to believe.

Almost the first thing which strikes one, in surveying the roll of the past masters of ornament, is the paucity of Englishmen among them. It is not until we come to our own

me that we find Englishmen taking the lead, ver, in ornamental design. No doubt there as plenty of good work done in England in he Middle Ages—whoever may have done it -but when we come to the period at which ames begin to be recorded, we are so far rom finding historic English names, that one s tempted to suppose that, as we borrowed ur Holbein from Switzerland, our Sir Antonio More, our Lucas de Heere, our Vandyke, ur Sir Peter Lely, and our Sir Godfrey Kneller, rom the Netherlands, so we may have imported uch artists as were engaged upon the better ind of decorative and ornamental design rom Italy, or wherever it may have been.

That some such men were imported we have een already. Torregiano and Da Rovezzano vould hardly have been called over here but or lack of competent English sculptors. There is no parallel in England to the schools of art which flourished on the Continent. We have nothing to compare with the metal-workers of Nuremburg and Augsburg, with he book-decorators of Lyons, with the enamellers of Limoges, with the glass-painters of Champagne and Normandy—to say nothing of the Italian schools. Our great English woodcarver, Grinling Gibbons, was born in London, but he only just escapes being a Dutchman. The Brothers Adam had to depend for the execution of ornamental detail upon Pergolese, Bartolozzi, and even Angelica Kaufmann. Chippendale, Sherraton, and the other famous cabinet-makers spoke, so to speak, in French, albeit with an English accent. The one really distinguished English designer of the last century was Flaxman, and his ornament was almost literally translated from the Greek.

In short, whatever English ornamentists there may have been, their names are to seek; and whilst there are so many names of men of other nationalities calling for comment, which time forbids me to make, I have not been disposed to enter upon that voyage of discovery.

Miscellaneous.

DECORATIVE ART SCHOOL IN FLORENCE.

A decorative art school under the patronage of the King of Italy was established in Florence by royal decree in the year 1880. The United States Consul at Florence says that this school is supported by an unlimited number of shares at twelve lire each per year; voluntary donations; yearly tax of ten lire per pupil; subsidies granted by the Ministry of Agriculture, Industry, and Commerce; the province, the municipality, the Chamber of Commerce of Florence, and other contributions. During 1891, the amount derived from shares was as follows:—From the Ministry of Agriculture, 3,345 lire; from the province of Florence, 15,000 lire; from the city of Florence (inclusive of rental of building) 2,000 lire; from the Chamber of Commerce and Arts, 3,100 lire; from various other corporations, 1,240 lire; from yearly tax on pupils, at 10 lire each, 220 lire; and from miscellaneous sources, 2,677 lire; amounting to a total sum of 27,582 lire. The instruction imparted at this school embrace sarchitecture, sculpture, painting, wood-carving, artistic ironwork, and almost every species of decorative designing and art embellishment. The pupil having fully completed the course of training and instruction, and after successful examination, is granted a certificate *ad hoc* specifying his attendance and success. The scholastic year extends from September 15 to July 15. The lessons are given every day, festivals and *fête* days excepted, between the hours of 8 and 12 a.m. from September until March, and between 7 and 11 a.m. from April until July. In both terms the first three hours are compulsory, and the fourth hour of instruction is optional. Pupils are received from the age of twelve years, and none are allowed to repeat more than one each of the four years of study. The institution is at liberty to retain any or all of the work produced by each pupil. The professional school of industrial decorative arts in Florence proposes to give artistic and technical knowledge which is adapted more to the development of Florentine industries based upon the art of drawing and modelling. The school is, therefore, more especially intended to give a training to young men in these two accomplishments, as may be applicable to any and all industrial and artistic decoration and designing, such as engraving, wood-carving, adorning or cutting of gold or silverware, stucco designing, mosaic work, and artistic designing in iron and inlaid woodwork. The course of study comprises a term of four years—two for elementary or preparatory classes, one for special or intermediate training, and the remaining year for practical and advanced work.

THE PRODUCTION OF COTTON GOODS IN CHINA.

Consular reports recently supplied to the Foreign Office indicate the progress that is being made in establishing the manufacture of cotton goods in China. Mr. Hausser states, in regard to Ningpo, that "the use of foreign machinery worked by hand for the cleaning of cotton is becoming general, and during the year some £300 worth of Japanese-made hand-machines, costing £2 3s. to £3 5s. each, were sent into the interior, mostly to Shao Hsing. The steam cotton ginning mill, established three or

four years ago on the bank of the river some two miles above Ningpo has been worked during the past year with continued and increasing success. The works have recently been considerably enlarged and new machinery added; since June last, when the extended premises were opened, the daily output has been increased to 390 piculs to 400 piculs per diem. Formerly 42 machines were worked; there are now 76 machines, each costing about $70, laid down here." Writing on the trade of Hankow, Mr. Gardner states that "the cotton factory at Wuchang has only just commenced working, and has had no perceptible influence on the trade so far; whether it will do so in the near or distant future is not at present easy to determine. If the factory can be supplied with cotton equal in quality to, and as cheap as, the best American, and if it can be worked as economically as a Manchester mill, there is no reason why it should not inaugurate a dangerous rivalry to the home and Indian factories, by encouraging other provinces to imitate the example of Hupei and erect factories. The great difficulty will be probably the cost of management." And in the course of a report on the trade of Chungking, Mr. Fraser refers to the subject as follows:—"The products of the Shanghai Cotton Mill appear for the first time in the Chungking returns. The quantities (60 pieces drills, 966 pieces sheetings, and 40,000 lbs. yarn) are naturally small, but the two former are valued as highly as the English article, while the last-named ranks with Indian yarn. Considering its advantage of nearness to the market, the Shanghai yarn may prove a serious competitor to Bombay mills, and when and if the Wuchang mills prove a success, Indian yarn may dwindle away as English yarn has already."

General Notes.

National Competition of Schools of Art.—The annual exhibition of works of students of Schools of Art will take place in the South Kensington Museum, on Monday next, July 24, from 10 a.m. to 6 p.m.

Exhibition at Porto Rico.—The Science and Art Department have received, through the Foreign Office, particulars of an exhibition to be held in November next to commemorate the four hundredth anniversary of the discovery of Porto Rico. The West Indian countries are specially requested to co-operate, and other nations are invited to send "objects that are or may become articles of commerce." Exhibits will be admitted free of Customs' duty, and no charge is made for space, which must be applied for by September 1.

The System of Awards at Chicago.—All the foreign Commissions, except those of France and Denmark, have, it is announced, abandoned the intention previously formed to withdraw their exhibits on account of dissatisfaction with Mr. Thacher's plan of awards. The *Chicago Herald* of June 22 says:—"The foreigners have come back, but they do not admit the virtues claimed by Mr. Thacher for his plan. One of them voiced the sentiments of the entire delegation yesterday, when he said they restored their exhibits to inspection because they were not willing to injure the Fair, not because they believed that Mr. Thacher's plan was the best. 'If we have not already proved our sympathy for this Exposition,' he said, 'we do it in this act. Our countries and our manufacturers are represented here at great expense,' he remarked. 'I do not believe any of the European powers will expend again what they have paid out here to make this Exposition a success. They have made heavy drafts on public funds and private enterprises, and rather than impair the history of the Exposition, which lives in the reports of juries of awards, we submit to conditions that are unsatisfactory and untried."

Mineral Springs in Japan.—The *Revue Geographique* says that there are few countries where the waters containing useful properties from a therapeutic point of view are as numerous as in Japan. The sources of mineral waters are so many that a vast number remain unused by the Japanese. The Japanese usually employ the mineral waters in the form of a bath, and in some places they take them in the form of a douche, placing themselves for the purpose under the cascade, or even under the cataract. The mineral waters may be divided into the four following classes:—Sulphur, saline, alkaline, and ferruginous. The springs situated at Atami and Ashinoyou, the former a saline, and the latter a sulphur spring, are very much in fashion. The former are situated in the province of Idyn, and the latter in the mountains of Hakona, in the province of Sagami. The Atami water spouts out with a force comparable to that of a veritable geyser. The *Revue* says that the position of these springs is a most agreeable one, situated as they are at an altitude of a hundred metres above the sea. As regards the waters of Ashinoyou, they are held in equal honour by the Japanese. The water from this spring emerges from the ground clear and limpid, but it is not long before it becomes troubled and deposits sulphur. Almost tasteless, it is yet strong in sulphoretted hydrogen. In the opinion of European and Japanese medical men, these waters are efficacious in cases of muscular and chronic rheumatism, and for certain skin diseases. In the province of Kü there are many sulphur springs which may be compared to the Luchon waters. In the environs of Mikko there are also a number of sulphur and hot springs. At Katsoura, Ureshino, and Kusatsu, the mineral springs enjoy a high reputation, and it may be said that in nearly all the provinces of Japan sulphur springs exist.

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Notices.

"OWEN JONES" PRIZES.

This competition was instituted in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of subscriptions to that fund, upon condition of their expending the interest thereof in prizes to "Students of the School of Art who, in actual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The following is a list of the successful candidates :—

Mary Caldwell, School of Art, Canterbury.—Design for a mosaic pavement.

Margaret Winser, School of Art, Dover.—Design for lace.

Joseph M. Sadler, School of Art, Glasgow.—Design for wool tapestry.

William Rewcastle, School of Art, Glasgow.—Design for a hanging.

Frank H. Smith, School of Art, Macclesfield.—Design for a carpet.

John E. Birks, School of Art, Cavendish-street, Manchester.—Design for printed cotton.

The next award will be made in 1894, when six prizes will be offered for competition.

Proceedings of the Society.

CANTOR LECTURES.

SOME MASTERS OF ORNAMENT.

By Lewis F. Day.

Lecture III.—Delivered April 24, 1893.

Renaissance art, I said last week, culminates in France in the reign of Henri II.

Architecture, in the hands of men like Androuet du Cerceau, Pierre Lescot, Philibert de Lorme, and Jean Bullant ; and sculpture, in the hands of men like Nicholas Bachelier, of Toulouse, and Hugues Sambin, of Dijon, take now a form more characteristically French.

The architects mentioned were also sculptors, more or less, and the sculptors were more or less architects. No one art was enough for a man in those days. He described himself as "painter and architect," "architect and sculptor," "architecteur et menuisier." That was possible, no doubt, in those more leisurely days, before specialism was ; but the many-sidedness of the architect is explained by the then significance of the word.

The term architect (if we may believe M. Adolphe Berty) was hardly known in France before the time of François Ier, and it was specially applied at first to an artist quite distinct from the constructor, who went by the name of "master mason" (as we know he did in the Middle Ages). Many of those who were distinguished as architects before the reign of Louis XIII. were only designers of architecture, who left to men whose special business was the carrying out of the construction and the responsibility for its soundness. This would account, perhaps, alike for the strength and for the weakness of their architecture, and certainly for the fame of men as architects, sculptors, and even painters, all in one.

Pierre Lescot (1510) will best be remembered as architect of the western façade of the Louvre ; but the frieze of little cupids holding up the Royal H., owes, probably, less to him than to Jean Goujon, who worked on it. Again, in the Salle Henri II., at the Louvre, he had the help of a carver of the name of Etienne Cramoy (1558), who also probably expressed himself, rather than Lescot, in his decoration.

Philibert Delorme (who, by the way, in his

design of the good architect, pictures him with four hands, as well he may, to indicate the multiplicity of trades in which he professes to be expert) is responsible for at least one ornamental feature, the *colonne à bossages*, the column with rings of sculpture in relief, which was such a marked feature of the design of the façade of the Tuileries. He did not precisely invent it. Serlio, for one, had used it before at Fontainebleau, but he was the first to make much of it; and he treated it in such a masterly way as to make it his own, and thenceforth the property of the French Renaissance. For the rest, Delorme's ornament is always rich, but there is no very marked individuality about it.

Hugues Sambin was a pupil of Michael Angelo's, who after his return from Rome was engaged on the sculpture of the Palais de Justice at Dijon; and it is to his influence that the character of 16th century Burgundian wood-carving is attributed. His work is characterised by a certain brutal energy. His taste ran in the direction of grotesque caryatid figures, with garlands, broken pediments, and such like.

Nicolas Bachelier was to Toulouse what Sambin was to Dijon; he too had worked in the studio of Michael Angelo, and the influence of Michael Angelo was distinctly to the bad so far as concerns ornament. Men seemed to think that they had only to carve a couple of rude figures slipping off a tomb, a doorway, a pediment, a broken one it may be, designed for no other purpose than that they might slip from it, and straightway they were Michael-Angelesque! One is content to let a Michael Angelo do what he likes, and be thankful; but the sacrifice of constructional, to say nothing of ornamental, design in architecture and furniture to a misplaced ambition to carve the figure, is more than we can forgive the lesser carvers of the 16th century. Caryatid figures are all very well in their way, but they won't bear the whole brunt of ornament. Designed with grace, carved with skill, used with moderation, confined relentlessly within the architectural lines of the feature they decorate, caryatides may add an element of human interest which some people (not I) feel the lack of in merely ornamental design; but they are admissible, it seems to me, only on the condition of the strictest obedience to the architectural composition. When they forsake the limits of the architectural lines, as towards the end of the 16th century they often do, and sprawl about the furniture they make pretence to decorate, they only remove still further from reasonableness a style of cabinet-making the design of which was founded, as the century advanced, more and more upon merely architectural lines, and less and less upon the purpose of the particular piece of furniture.

In so far as the architect was instrumental in determining that decorative design should be on set lines—serious, monumental, conforming to the construction of the building, his influence upon ornament was entirely to the good. In so far as he substituted for ornament, with something like life and growth in it, what I may call the trimmings of architecture, in so far craftsmanship would have done much better without his interference.

One is tempted sometimes to wonder what might have been, but for the misguided use of building-forms in cabinet making and other crafts. Column and arch, cornice and pediment, which have their place in architecture, are merely purposeless addenda to the design of furniture and such like. Yet we are so accustomed to a sort of architectural formula of design, that we hardly dare do without it, and design according to the actual conditions of the craft in question; and if we do so far depart from precedent, it is at the risk of offending prejudices, from which we ourselves, perhaps, are not quite free.

To return to the masters, some of the men I have mentioned survived Henri II. and his style. Du Cerceau himself lived almost as long as the race of Valois, and died only a few years before the accession of the Bourbons in the person of Henri Quatre. In Du Cerceau's work, as in that of Cousin, and again in the designs for goldsmith's work, by René Boyvin (who engraved also some of Rosso's decorative designs) we see the influence of that exaggerated cartouche work, which announces the advent of the barocque style. But, on the whole, the earlier French form of the cartouche did not go much beyond the bounds of restraint.

In the panelled ceiling of the Salle Henri II., at Fontainebleau (on the screen) we have an irreproachable use of the cartouche. We are still in the Renaissance, where the cartouche is only a feature distinguishing the style from that of the pure cinque-cento, and have not yet arrived at the baroque, which is pretty well all cartouche. It was in Flanders, among the lovers of light and shade, but especially of shade, that the cartouche found its fullest and most emphatic expression. The

fashion was apparently "boomed," as we should say, by the Brothers de Vriendt, best known under the name of Floris. Franz Floris, the painter, was a pupil of Michael Angelo; Cornelius was a famous architect and sculptor; Jacob was a glass painter; and Jan, a painter upon pottery.

The Brothers Floris, or de Vriendt, created, it is said, the style of ornament consisting of elaborate cartouche work with inter-spaces occupied by figures of men and beasts, birds, flowers, fruit, ribbons, and even drapery, which goes in Flanders to this day by name of the Floris style.

Franz Floris was a very important personage. It is to him that was entrusted the design of the triumphal arches erected to celebrate the entry of Charles V. into Antwerp, and afterwards that of Philip II. But his work marks a sad falling off from the noble achievement of that other Flemish pupil of Raffaelle and Michael Angelo, Bernard van Orley, who was Court painter to Charles V., and who made Brussels for a time the capital of Netherlandish art. (The tapestries at Hampton Court, depicting the life of Abraham, are said to be by Van Orley; and the great transept windows in the cathedral at Brussels are his.) He was of course primarily a painter, but, if he did not design ornament, he had a masterly control over it.

A distinguished sculptor of the period, florid, but not yet hopelessly addicted to the cartouche, was Peter van Oost of Bruges, who carved the great oak screen and ceiling in the Hotel de Ville there.

About the first frankly to adopt the cartouche in Germany was Jost Amman, a pupil of Virgil Solis (of whom I shall have something to say later on); the two worked together for the Frankfort printer Feyrabend. Amman took very kindly to the style, and mastered it. It suited his robust temperament. A degree of clumsiness there may be in his design, but it is at least always manly; there is in all he does something of the Teutonic energy and strength so conspicuous in the Nuremberg masters, of whom he was the immediate descendant. He is florid, of course; in common with Dürer, he has a tendency to rustic detail; he is hasty sometimes, and even scamps his work; but his fertility is wonderful. He was very fond of animals, and could draw them much less conventionally than he (rightly) chose to do for heraldic purposes. There is an instance on the screen, in one of the little head-pieces, of which he designed so many for book decoration; the creatures are very amusingly introduced, natural enough, and yet composed with due regard to ornament. If it may be said that with Jost Amman begins the decadence of German art, it cannot be said that he does more than begin it. He leaves it for others to carry it to the dreadful end.

The principal illustration on the screen is taken from his "Wappen Buch," a book of shields of arms, which is in itself enough to justify his title of master. The worst that can be said about it is that it is rather late in style—which is not altogether his fault.

"There never was an artistic period," says Mr. Whistler, oracularly. Well, perhaps not, certainly not if by artistic period is meant a time when all men were artists, and all artists were accomplished. But, of a certainty, there have been seasons when art blossomed more freely than at others, and as certainly, or more certainly, there have been times when art was in a very bad way, so bad a way that it was a misfortune for an artist to be born just then, unless, by uncommon chance, he happened to be the man who was born to set things right. Even such a man is not perhaps the host in himself we take him to be; he only sums up the genius of the time, no more. Period goes, it must be acknowledged, for a great deal in a man's art; conditions which are none of his making may hamper him terribly, stultify him perhaps; and just as we praise the fortunate man beyond his real deserts, so we are too hard upon the unfortunate. Their crime perhaps is only that they have fallen upon evil times. I say this here, once for all, in mitigation of sentence I may have passed, or may have to pass—one cannot always be qualifying one's statements. I take it, it is best to speak frankly as you feel, and trust to the good feeling of your hearers to correct anything there may be of unconscious injustice in the expression of your feeling.

Tobias Stimmer, who began by painting the façades of houses at his native town of Schaffhausen, but who worked eventually with Amman for the printers, designs sometimes so much like him, that it is difficult to distinguish, at first sight, between the two; but Jost Amman was distinctly the better man at a cartouche, and, indeed, at ornament generally.

With both of these men, the figure played a most important part in ornament. The cartouche may even be said to be only the framework to it.

With Jan Fredeman, of Friesland—De Vries, as he was called (and with his son, Paul de Vries, after him), the cartouche was all in all; and if the figure was introduced it was by way of ornament upon it, not in association with it. I show you once again the design by Jean Cousin, which you saw last week: that shows the figure as a very important feature in the design, but used, as I said, in association with the cartouche. In the design by De Vries, on the contrary, the human masks, and so on, are more by way of ornament applied to the cartouche itself. The distinction between the two is obvious enough, I think.

De Vries worked with Floris on the aforesaid triumphal arches, no wonder, therefore, that he carries on the traditions of his master, and fulfils, as one may say, the promise of the brothers Floris. That one wonderful instance on the screen is enough to show to what excess cartouche work came to be carried. It is all bolts and bars. The ornamentist has here given way to the smith, and especially to the locksmith, who riots in the assertion of his trade. Compared with this, the cartouches of Henri II.—even that cartouche of Cousin's just shown—are marvels of reticence; and our English Elizabethan and Jacobean strap-work is only a pale reflection of the misapplied metallic manner of design.

For my own part, I must confess that the ornament which resolves itself into locksmiths' work ceases, by precisely so much, to interest me—just as does the so-called ornament which is made up of mere architectural features, Gothic canopies, classic colonnades, or whatever they may be.

De Vries, who, by the way, has been dubbed "the Du Cerceau of Holland"—so great was his influence—was especially skilled in perspective.

His popularity explains itself when we look back at German and Flemish art, and remember what its characteristics were. Even in Gothic work, a certain playful formality of tracery indicates the Teutonic hankering after geometric form, and, at the same time, we see, from the beginning, signs of an energy which is not under restraint, a tendency to excess whether in the elaboration of mechanical device or of luxuriant scroll-work, a delight in intricacy of detail, a persistent preference of the rich to the refined, of the strong to the delicate, of the fantastic to the beautiful.

This is more plainly marked than ever in the work of Wendel Dietterlin, of Strassburg. He happened to be born in the year 1550, and was good to die in 1599, so that he represents to a year the latter half of the 16th century—as he represents the culmination of the whimsical and wilful in design. The extravagant examples on the screen are quite among the most sober and serious of his multitudinous designs. To the right you have a design for something analogous to the rustication of stonework, in which the forms are not adapted but absolutely transferred from metal-work, the facetted bolt-heads assuming something of the appearance of those "jewels" so characteristic of a certain kind of German work, and of our own Elizabethan, or rather Jacobean, carving. In the ironwork, framed by the architecture to the right of the screen, Dietterlin is at his very best. The lines are really graceful, and the fantastic element is here not so much out of place: that might almost have been designed by Du Cerceau. In the architecture itself you have a hint, but only a hint, of the lengths of elaboration and extravagance to which he would go. He would bend, and twist, and bolt together architectural members as though they were plastic, pierce one by the other, and cut off what was in the way. He was a man of literally boundless imagination; of restraint he had no notion.

So wild were his freaks of design that, as Herr Lübke says, it is some satisfaction to think that the greater part of them were never carried out, could not indeed be carried out, and never got beyond the patient paper to which the designer confided them.

But the greater the extravagance, the greater the success, apparently. Duke Ludwig of Wurtemberg buguiled him to Stuttgart, and his fame spread over Germany. The publication of his first volume of designs was answered by an immediate demand for a second—and new and enlarged editions followed hard upon their first appearance. The Jesuits in particular (an Order which has consistently distinguished itself by its perverse endeavour to do some new thing in architecture) welcomed him with open arms; and only the physical impossibility of the task deterred them from realising his wildest dreams. Dreams I called them. It was an architectural nightmare, but a nightmare that only an artist could have dreamt.

So much for the burlesque of architectural ornament. Let us go back now, for a while, and trace another and a happier influence

which pervaded 16th century ornament. I have spoken of the geometric tendency of the Northern mind. There was other geometric influence at work, derived from a quite different source, namely from the East.

We must remember that in the 16th century the Mediterranean was the world's highway; and Venice was the port of Europe. Oriental silks, porcelain, arms, jewellery, found their way, inevitably, into the Italian markets, and were held most precious. It became, indeed, quite a common thing to imitate them; witness the copies of Broussa velvets, and of that geometric inlay to which allusion has already been made. Witness, again, early Italian faïence and brocades, made beautiful with mock Arabic inscriptions, introduced wholly by way of ornament. Oriental artificers also found their way into Italian workshops. Cellini tells us how he learnt of such a one to damascene in the Eastern manner. So it happens that, even in the first half of the 16th century, when the Renaissance was at its height (notwithstanding that the idea of the Renaissance was to revive the antique manner, and great part of ornamental design consisted in the rearrangement of ancient details) certain new and distinctly Oriental features crept into the style —by way of Italy in the first place, although it was in France and Germany that they were more generally and more cordially adopted.

It is plainly to the East that the Renaissance owes not only the ultra-conventional leafage characteristic of Mohammedan art, but the intricate interlacing ornament, which must in reality have been present in the minds of those who first adopted the word "Arabesque," though it soon came to be used, quite inappropriately, in a very different sense.

A French form of that same strap-work is shown in the work of Oronce Finé, a mathematician of Paris, who ornamented the pages of his own works, very admirably as you see. Those initial letters of his to the side of the screen are more in the ordinary way; but in this delicate and graceful interlaced work he was very much himself.

Dürer, perhaps, in that braided pattern which was shown last week, was inspired at the same source, but here the lesser artist is distinctly the better man of the two—it is rather the case of the mouse and the lion.

Finé was working somewhat on Italian lines. A more distinctly French version of strapwork occurs in the work of the great bookbinders, who best illustrate, if they did not originate, a very beautiful phase of the style of Henri II.

Two such bookbindings are shown on the screen, together with a border of Italian inlay betraying the same Arab influence. The border is by Gio. Batt. da Conegliano, a pupil of Bellini. The authorship of the two French bindings is not so certain. The cover on the right is attributed to Du Cerceau—the foliated ornament, you will see, is as nearly Arab as could be. In the other example the foliation is more Italian—and in the strapwork there is indication that the designer had in his mind the idea of a cartouche. These four little breaks in the central ring of strap-work only fall short of actually representing the curling-over of the straps at those junctures, because it was difficult to represent it by means of bookbinders' "tooling." In the smaller quatrefoil shapes, you see still more plainly the turnover, with its volute-shaped edges, which is so characteristic of the cartouche, but rendered in the flat way, it does not obtrude itself upon our notice. The design of the rare Faïence d'Oiron, or Henri Deux ware (which was at its best between 1538 and 1560) was quite in the same manner as these bookbindings. The names of two of the most distinguished potters of the period are Charpentier and Jehan Bernard.

Another man, who made a great reputation as a book decorator, was Geoffroy Tory (1480). He designed bookbindings for the famous Grolier (possibly with Grolier at his elbow), and also for King Henry, for Diane de Poitiers and for Catherine de Medici, of which that on the screen may well be one.

Tory was a man of education, and one sees it in the refinement of his work. From the University he went to Rome and Bologna to study. He returned afterwards to Paris, settled there, and, after having attained the position of Professor of Philosophy, took definitely to design, studied engraving, and went back to Italy for three years, with the specific purpose of perfecting himself in art this time. He seeks always in his ornament simplicity and beauty of line; it is not often that he indulges in the grotesque or eccentric; and he arrives sometimes at remarkable elegance of design. That is shown in the example to the left of the screen, a masterpiece, I think, of delicate tooling.

The second design, in which the interlacing is free of any suspicion of cartouche work, is a binding of Grolier's, and is delicate enough to be also the work of Tory. What foliation there is is again Arab.

Yet more distinctly Arab is the detail of

some of Solomon Bernard's ornament, which has much of the grace, as well as the intricacy, of Eastern work. Bernard—Le Petit Bernard, as he was called—lived and died at Lyons, and was in great request among the famous typographers and printers there. No one of his time (he died in 1570) had more influence on the book-decoration of the period. It is his ornament, of course, and not his figure compositions to which I draw your attention. It is rather curious to trace how like, and yet how unlike, is his work to the genuine Eastern thing.

In Germany the same kind of thing was being done. Holbein, for example, would design that kind of detail for surface decoration, and design it very well; but the man who made the moresque manner most entirely his own was Peter Flötner, of Nuremberg. He was a sculptor and engraver, and designed for intarsia and for goldsmiths' work. Occasionally, he worked in the manner of Italian grotesque, but the greater part by far of his published designs are in the manner of the panel upon the screen: he represents more fully than any one else the German version of the moresque. The French, by the way, call that class of ornament to this day "nielle," plainly referring to its origin in the niello which the Italians borrowed from Oriental damascening.

A more consummate artist in the engraving of ornament was Virgil Solis, some of whose work I show you. He, too, was of Nuremberg—the son, one may suppose, of a father very much bitten with the classic fever, since he called him Virgil. Much of his work, and perhaps the best of it, is in the quasi-Oriental manner. In the framing of the topmost ornament on the screen, you have a very flat version of the cartouche. In the ornament below, you see how fond the artist was of varying the monotony of filagree by broad bands of strap-work, which recall the French manner. One realises, in looking at the designs on the lower part of the screen, how valuable those plain surfaces of polished metal (these, of course, are designs for damascening) must have been in execution. One is led even to surmise that the use of this kind of strap-work grew out of the practice of damascening, and was initiated by the metalworkers. In his later work, Solis proceeded in the ordinary Italian manner. There is extraordinary variety in his design, which is explained by the fact that many of the 800 designs bearing his monogram were merely engraved by him. One is led to wonder if, beautiful draughtsman as he was, and accomplished engraver, he invented much of his own at all. Certainly he has no style of his own, and it is often only by the monogram that we associate a design with his name.

My friend, Mr. George Clulow, who is the fortunate owner of an almost unique pack of playing cards by Solis, has lent me slides of two of them, which you will see are very different from the ornament I showed before, and substantiate what I said about versatility.

Among the men from whose designs Virgil Solis worked was Wenceslaus, or Wenzel Jamitzer, or Jamnitzer, goldsmith and mathematical instrument maker, who wrote a book about perspective, and probably also Christopher Jamitzer, his more famous nephew, who, in the opinion of some, shared with Cellini the fame of being the goldsmith of the Renaissance. One finds in their work a severity which amounts sometimes almost to hardness, in combination with a naturalism approaching to the rustic—the effect of which is not happy.

Virgil Solis designed largely for jewellery and goldsmiths' work; and it is noticeable that the jewellers and goldsmiths of the period developed a style of ornament which, whilst it is obviously akin to the designs for bookbinding, has a more metallic and a more graven character of its own. This is especially the case with some of the Netherlanders, who developed a kind of ornament which consisted of, as it were, a network of lines—usually very gracefully designed—with here and there the emphasis of a broader form, but in which there was no pretence either of floral growth or of actually moresque form. The detail indeed suggests—often only very remotely—the cartouche forms so dear to the Dutch; it reminds one also sometimes of open lace work—minus the connecting stitches—and it recalls occasionally, not when it is at its best, the quasi-ornament designed by the simple process of writing your name on a sheet of paper and doubling it over whilst the ink is wet to see what comes of the squash.

This kind of thing went on from the beginning of the second half of the 16th century until well into the 17th. Guilhelmus de la Quevellerie (that is his work in the bottom right-hand corner of the screen) was doing it in Amsterdam in 1560, whilst his neighbour, Baltazar Sylvius, was doing niello precisely such as Virgil Solis might have done. Gerært van Ryssen, in Holland, and Sezenius, Simony, and Drusse, in Germany, were engraving much the same kind of thing in the first

quarter of the 17th century. In France it was taken up by several men, some of whom are illustrated. I show you illustrations of the work of Stephanus Carteron, Hirtu, Fontin, and Costanctius.

Even in the latter half of the century we find Michel le Blon, Blondus as he was called (an important personage at Amsterdam, he served, I think, as ambassador on one occasion), carrying on the old traditions; and quite at the end of it such men as Paul Birkenhültz, in Germany, and Friedrich Jacob Morisson, Jean Louis Durant, Simon Griebelin, and Jean Bourguet, in France, continued to design jewellery in much better taste than what was being done in other branches of ornament. Griebelin, by the way, came eventually to England. Bourguet in his later years succumbed, it is true, to the influence of the Regency, and designed jewellery which was not so much ornament as a conglomerate of precious stones—a vulgar style of thing still greatly in favour with persons who glory in the display of diamonds.

Daniel Mignot, a Frenchman working at Augsburg at the end of the 16th century, and Esaias Van Hülsen, a Netherlander settled at Stuttgart at the beginning of the 17th century, are men whose names should not be passed over quite in silence; but, as I have explained before I think, it is impossible to illustrate more than a limited number of men, and I am anxious not to inflict upon you either catalogues of bare names, or full descriptions of the doings of designers whose work I am unable to show you.

In the works of the 16th century silversmiths—Bernhardt Zan, Paul Flyndt, Hans Siebmacher, George Wechter—all of them of Nuremberg, the strap-work which was a feature in Henri II. design, and which Solis introduced more in the Oriental manner, assumes, you will see, a very different aspect. The lines not only interlace but they interpenetrate, and the shapes (now often angular) have the appearance as though they had been cut out. Eventually they develop themselves into a sort of open cartouche work, already foreshadowed in the work of Mielich, which I showed you last week, and which I show you again for a moment to compare.

To say that we have the origin of the cartouche would not be quite true. The cartouche is perhaps more properly a development of the shield. Once begin to shape the shield fantastically, to twist it about and to roll up its edges, and you soon arrive at a cartouche, or something very like it; but the elaborate interlacing and interpenetration of the cartouche which we find in the ornament so especially characteristic of the Netherlands, is not easily explained as a mere fretting and contorting of the shield—rather it seems to me to result from the meeting, and the inter-marriage of two *motifs*, shield-work and strap-work.

Be that as it may, the particular style of strap-work common to the silversmiths of Nuremberg towards the end of the 16th and the beginning of the 17th century, was very much the outcome of their peculiar mode of work, of *punching*, that is to say, which Paul Flynt was one of the first to adopt, if he did not invent it, as some say he did. Punch in hand the silversmith modified the broad bands which had occurred already in damascening and engraving into what you see. That goblet to the right is by Paul Flynt. The value of those more or less formal straps of plain smooth silver among the bossy ornament, in which the silversmiths so freely indulged, is obvious; they were very easily punched up, and they were a never-failing foil to the exceeding richness of the foliage; and when it came to terminating the straps, it was the easiest thing in the world to beat up the ends until they seemed to curl over cartouche wise.

This is a style of enrichment which has been cruelly over-done; it lends itself easily to abuse. There was often, besides, as in the work of Jamitzer referred to, a discrepancy between the mechanical lines of the strap-work and the naturalistic rendering of the foliage; but the men who used it were in some sort masters; and they evolved certainly a style which, whether we like it or whether we do not, is eminently characteristic of, and admirably suited to, the process of hammering. In the work of Wechter, in particular, the balance of design is noteworthy. The proportion of strap-work to floral ornament, the relation of one to the other, the conventionalising of the flowers and so on, and the unity of the whole effect, are merits which speak for themselves.

Another Nuremberger, Hieronymus or Jerome Bang, made the strap-work itself burst out into foliation, and introduced amidst it figures and animals; but the forms of his detail still suggest metal-work. They are somewhat in the style of Theodore de Bry, a goldsmith of Liège, who was banished in 1570 on account of the active part he took in promulgating the Lutheran doctrine, and settled in Frankfort, where he practiced engraving,

and kept a book-store. He ranks as one of the most important of the Little Masters; but I think Bang's work was better, though he did, so far as we know, much less, and is, consequently, much less famous. De Bry had two engraver sons, who helped him, and perpetuated his manner.

I have omitted to mention the name of Adrien Collært, a designer, engraver, and printseller of Antwerp, who, in point of time, comes before De Bry and Bang, and whom they may be said to follow; in fact, he may be looked upon as illustrating the transition from the arabesque of the Italian kind—that, for example, of Da Udine—and the more metallic style which we associate with the Netherlands. There is an ease about Collært's ornament indicative of a master in his way. He had a son, Hans, more famous than his father, and in some respects, superior to him; that is to say, Hans, thanks, in a measure, to his sojourn in Rome, attained to a degree of grace and delicacy of form in his designs for jewellery, to which his father never reached. But there was more individuality in the work of Adrien.

Perhaps the most remarkable ornamentist of the middle of the 17th century was Heinrich Janssens, an engraver, who worked both at Amsterdam and at Antwerp. The familiar strap-work assumed in his hands quite a new aspect. For lightness, grace, elegance, there was no one of his period to touch him. The ease with which he wound his straps about, and the way he made his figures grow out of them, the beauty of the figures themselves, the fancy he displayed, the fertility of his invention, are alike remarkable. The forms he used were the forms of the period. He was not original enough to invent a new style (no man ever did), but he invented a version of the prevailing style which was all his own, and so proved himself quite the most original ornamentist of his day. In him, in fact, the expiring art of design flickered up for a while.

Lastly, there was Lucas Kilian, of Augsburg, an engraver, who, by his skill on copper, gave the last finishing stroke to the by that time decrepit art of wood engraving. He was a marvellously ready and accomplished designer, and some of his ornamental detail is very good; but it is disfigured by shapes resembling the contorted features of the human face, shapes unbeautiful in themselves and unpleasant in their suggestion.

After that, we have such men as Unteutsch, a cabinetmaker of Frankfort, who accomplished the impossible, and did invent a style—but it was an "impossible" style. Its forms were all based upon the convolutions of the human ear, and it went by the name of the *auricular* manner. Needless to say that it had a certain vogue—as many another extravagant and hideous folly has had, and will have! This, for the moment, was the last word of the decadence of design in Germany.

We have drifted you see entirely away from French art. French art itself had drifted away. That is easily explained. In the reign of Henri II. the exuberance characteristic of the period of François Ier had spent itself. Art had sobered down. Jean Goujon had taken the place of Cellini, and a style of art was developed in which there was perhaps less "go" and certainly less bombast. A little more, say the French critics, and it would have been cold. They even see in it a trace of Protestantism. Perhaps the artistic atmosphere was rather rarified up there, for it was the topmost point of the French Renaissance—after that begins the descent, and we come down with a run.

Catherine de Medici, indeed, reigning in the name of Francis II., gave to art for a while a renewed impulse in the Italian direction; but the wars of religion were not favourable to progress in art; the later Valois were too busy keeping themselves on their thrones greatly to encourage art or industry, and the school of Fontainebleau and its traditions died out with the dynasty. Meanwhile the Germans, after the peace of Augsburg, in 1555, had got well over their troubles, and had settled down to a period of some sixty years' prosperity. The Dutch also had succeeded in shaking off the Spanish invader and were a flourishing Republic, at the head of European commerce. Manufacture did not, of course, thrive in France during the civil wars—it was easier to import than to make—and they relied at last so much upon importation, and home production fell so entirely in arrear, that Henry IV., at a loss for competent carvers in ebony (foreign woods were now all the fashion), had to send French workmen to the Netherlands to learn their trade. That did not make their style more French. Flemish influence, in short, permeated French art, and that sad and heavy development of it in the earlier part of the 17th century, which is known by the name of Louis XIII. (though he was but a cypher, of course, in the hands of Richelieu and his mother), that ponderous style, with its cartouches and its ballusters,

its caryatid figures, its dull mouldings, its gross swags of fruit, is more characteristically Flemish than French; and when, eventually, Marie de Medicis bethought her of decorating the Luxembourg, nothing would do but she must send for Peter Paul Rubens. He came, with all the *prestige* of a phœnix, and found Paris ready to accept whatever came from him as the gospel of art—another strong man, whose genius carried all before it, sweeping taste along like a cork! Fancy Rubens as arbiter of taste!

Needless to say, that the people who were ready to open their arms to him had long since fallen away from their devotion to pure and beautiful form, and delighted only in the luxurious. Sculpture (which is dependent on beauty if not absolute severity of form) was in a very bad way. Strange and costly materials, now first imported from all quarters of the globe, (mainly through the agency of the Dutch, who were for the time the bagmen of Europe), were more esteemed than any art with which the carver could enrich them. Delicate ornamental inlay was less appreciated than the incrustation of furniture with amber, lapis-lazuli, or other unsympathetic substance, so long as it was precious; and, worst luck of all, the day of the upholsterer was at hand, nay, it had come, as you may see, in the stuffy interiors depicted for us by Abraham Bosse.

Bosse was the most prolific Frenchman—if he were a Frenchman—of the reign of Louis XIII., but his architecture and ornament have not much to recommend them; his design is dull, massive, and oppressive enough to make us wonder whether he may not have had Dutch blood in his veins—it is not quite a French name, Bosse. He is best known by his engravings, but even they are sad and uninviting.

The one Frenchman who at last worthily represents his country is Simon Vouet. He was painter to the king, and worked, besides, for the great Cardinal Richelieu. His work forms a link between lingering Renaissance tradition and the art to come—the art, that is to say, of Louis XIV.

But that is a branch of the subject reserved for my next lecture, when I shall have more to say of Simon Vouet. He announces, so to speak, the new style, upon which I have not now time to enter.

But I have yet time to-night to say a few words on the general subject of the masters of ornament. There is a point of view from which this series of lectures might be considered worse than useless to the student of design. We know perhaps too much, rather than too little, of the work of other times and other climes. We have lost something, certainly—a great deal indeed—by the disturbance of that simple-minded and whole-hearted devotion to a modest ideal of craftsmanship, which was natural to the men of the Middle Ages, and which did not quite die out until, comparatively speaking, modern days.

And, it may be contended, that to inquire yet more curiously into the art of the past and into foreign art, is still further to confound matters, still further to confuse the mind of the artist.

My answer to that is, that much as we may prize the *naïveté* of the early workers, priceless as their simplicity may be, and as I admit it to be, that is past; it is an Eden from which the artist, once having tasted of the tree of knowledge (whether that knowledge be good or evil), once having tasted, is driven never to return. Regrets are idle, clamouring at the gate for re-admission to the lost paradise is of no avail; the one thing that shall profit is to set to work and dig—to dig deeper and deeper, to turn over again and again the soil of ages gone—in the hope, and in the faith that out of it will spring in due season the germs of an art that we may call our own, and that shall ripen at last into a harvest which, whether it be rich or whether it be poor, is the only harvest we have any chance of reaping on this earth. We can no more go back to the sweet simplicity in which we find such a charm than we can go back to our childhood, dearly as we might wish it. We find ourselves in the 19th century, with all its advantages and with all its disadvantages, and we have got to go through with it, in desperation, if there is no other chance, or in hope, which will make that chance more likely.

We go too quickly, we cram ourselves with information, if not with knowledge; but the alternative is not between cramming and ignorance. It may have been (in some senses it certainly was) an advantage, an enormous advantage to the old-world artist, that the range of his experience was so limited—it set bounds to his efforts, which it would demand in us almost superhuman self-restraint to accept of our own free will. But what use in setting back the clock when time is all the while running on? There is no occasion, I admit, to overweight ourselves with learning—that would only hinder us—but we cannot afford to be

more ignorant than other men; we must be up to the level of contemporary enlightenment.

The cure for that complaint of art which comes from a surfeit of good things, is to starve for awhile, but only for a while. Even that may not be necessary. A little more and nature relieves herself. A moment's sickness and the cure is effected, a healthy appetite asserts itself once more, knowledge is digested, experience is assimilated, and the artist, refreshed and strengthened, is more an artist than ever.

To talk of the sufficiency of God-given faculties is pernicious nonsense. As if God did not give us also the faculty of learning by all what has gone before us—the human faculty which distinguishes us from our four-footed cousins! The more certainly you possess any heaven-sent faculty—and let us all hope we have a spark of it—the more certainly you possess such faculty, the more imperative it is that you should be equipped with the knowledge necessary to its full exercise, and the less danger is there of such knowledge hampering or hindering it. The individuality which is puffed out of a man by the breath of education, was never very powerful at the best: a feeble spark may here and there have been extinguished, which it might or might not have been worth while to nurse; but no shining light was ever so quenched, nor any spark likely to develop into a flame.

Those who depend upon the experience of others are weak; those who have no knowledge of anything beyond their own instincts are altogether unequipped.

Miscellaneous.

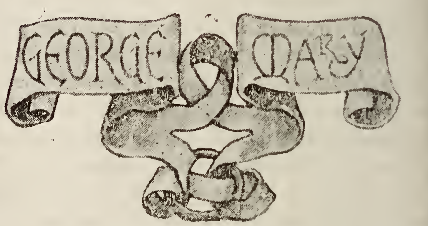
ADDRESS TO H.R.H. THE PRINCE OF WALES.

The Address to H.R.H. the Prince of Wales, on the marriage of their Royal Highnesses the Duke and Duchess of York, printed in the *Journal* (*ante* p. 793), was illuminated by Mr. Lewis F. Day; and the Council have resolved that, in addition to the print of the address, a reproduction of the design shall appear in the *Journal*. Mr. Day has been so good as to give the following explanation of his design:—

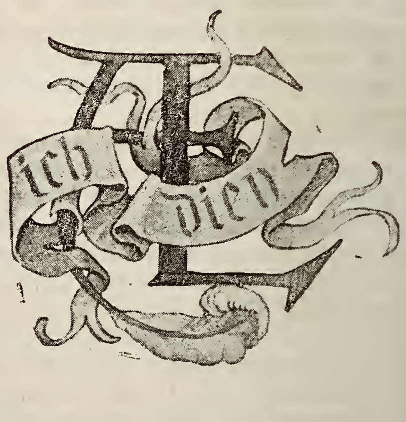
Within a border, made up, for the most part, of the letters G and M, connected by interlacing knotwork (interrupted at the top for the introduction of the date), the design is divided, for convenience of folding, into two halves.

The one side contains the address, in gold colour, like the border. The other is designed to form a decorative panel.

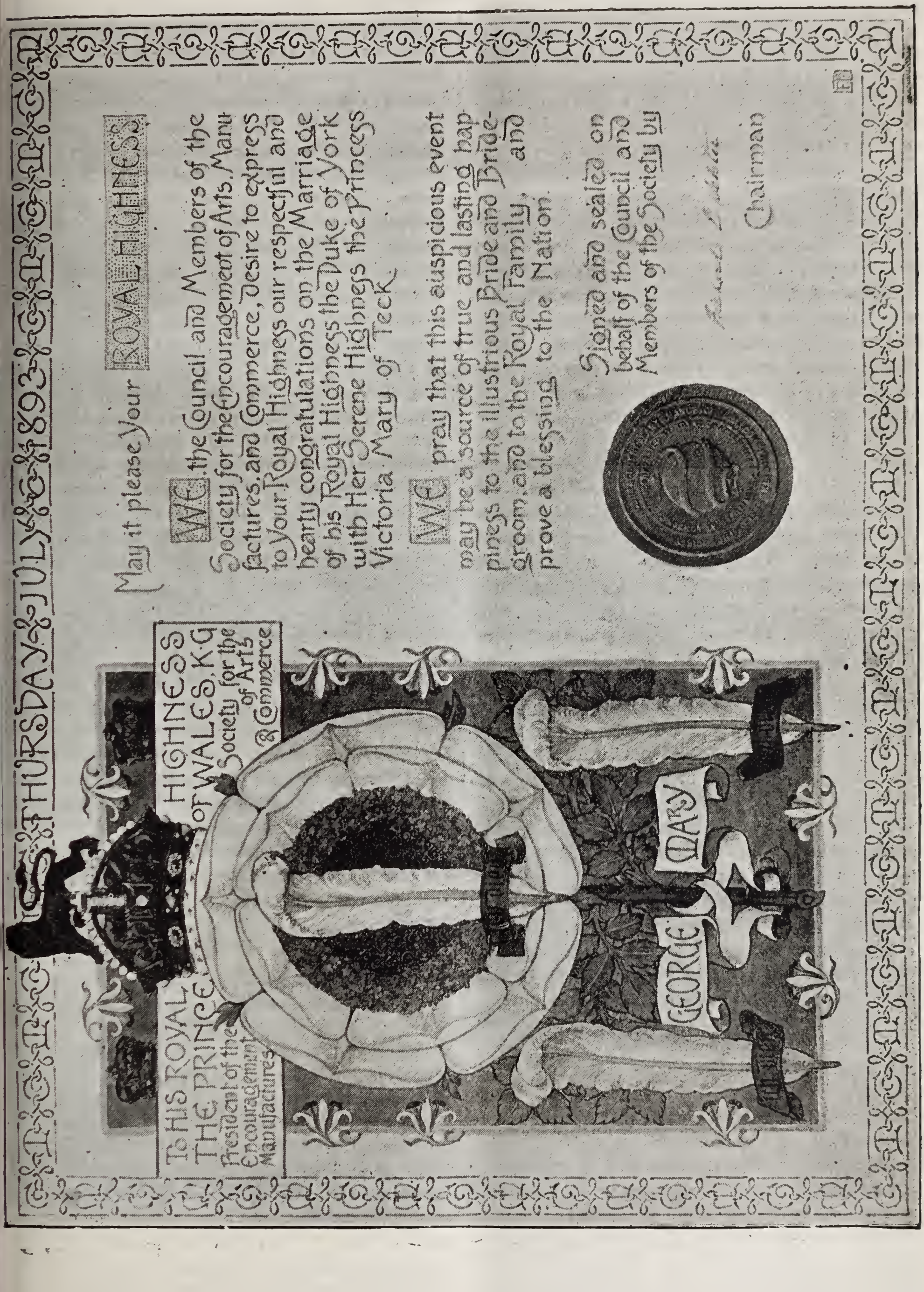
The main feature of the design is the white rose of York, enclosing a wreath of pink may, within which, in place of stamens, are gold coloured letters, G and M, again. The foliage of the rose forms a band of lighter green across the lower part of the panel; the section of its stalk reveals a minute blood-red heart; and round the stem is twined a label, inextricably interlaced with the wedding ring, and bearing the names GEORGE and MARY—the latter a compromise between the baptismal name of the Duchess of York, Mary, and the more popular May.



Next in importance in the design are the three ostrich feathers, which form the badge of the Prince of Wales. The Royal Crown, the crowns of Prince George and Princess May, and the marginal lillies and the superscription complete the composition.



The photograph renders the design fairly enough, except that the background should be relatively much darker, and the gold colour in the crowns and in the labels across the feathers, should be much lighter.


THURSDAY JULY 6 1893
To HIS ROYAL HIGHNESS
THE PRINCE OF WALES, K.G.
President of the Society for the Encouragement of Arts Manufactures & Commerce
May it please Your ROYAL HIGHNESS.
WE the Council and Members of the Society for the Encouragement of Arts, Manufactures, and Commerce, desire to express to Your Royal Highness our respectful and hearty congratulations on the Marriage of his Royal Highness the Duke of York with Her Serene Highness the Princess Victoria Mary of Teck.
WE pray that this auspicious event may be a source of true and lasting happiness to the illustrious Bride and Bridegroom, and to the Royal Family, and prove a blessing to the Nation.
Signed and sealed on behalf of the Council and Members of the Society by
Chairman
GEORGE
MARY

THE CHINESE POSTAL SYSTEM.

The United States Consul at Fuchau says that the Chinese have not yet established any Government post-offices or postal system for the masses of the people, although private enterprise has for many years rendered communication easy between the people in all parts of the empire. This is conducted through what are called "letter shops." No stamps are used, but the "chop" of the keeper of the shop is always placed upon the envelope. Imperial edicts and other official despatches are carried from city to city, and province to province, by couriers, who are very expeditious, being in some parts provided with horses at convenient relay stations. Despatches are thus conveyed, in cases of emergency, 200 or 250 miles a day. In districts where horses are used, each station-master is required to keep on hand from ten to twenty horses or donkeys, and the local official is held responsible for all delays that occur. These official couriers are not allowed to convey private despatches or letters. At the treaty ports "letter shops" are used by the natives only, but in the interior, or places not reached by the foreign postal arrangements, they are employed by foreigners as well, though chiefly by missionaries. All letters and parcels to be sent may be registered and insured. When given in at a "letter shop," the contents of an envelope are displayed before it is sealed up, and stamped with the "chop" of the shop. Charges for the transmission of valuables are made on a percentage of declared value, and, as is the case with letters, differ according to the distance to be carried. A receipt is given, and the shopkeeper then becomes responsible either for its safe delivery, with unbroken "chop" or seal, at its destination, or for its return to the sender. In some parts of the empire, about two-thirds of the expenses of transmission are paid by the sender, the remainder being collected from the receiver; thus, the shop is secured against entire loss from transient customers, and the sender has some guarantee that his letter will be conveyed with despatch. The other feature, much appreciated by native merchants, is that of keeping an open account with the shop. Charges for service rendered are entered against regular customers, and settlements are made monthly. In case of loss, it is seldom necessary to call in the aid of the courts, the force of competition being sufficient to ensure reasonable settlement. There are said to be nearly 200 letter shops in Shanghai, though, in many remote villages, there are none. The *employés* of the several shops are earnest in working up patronage, and go from house to house seeking customers. In the northern provinces, where horses are plentiful, and roads are more suitable for such travel, the letter carriers commonly use horses or donkeys, which are supplied at stations about 10 miles apart. Each messenger carries from 70 to 80 pounds of mail matter, and travels about five miles an hour, much more slowly than the official carrier. When the messenger arrives at a station, a few minutes only are allowed to change horses, when he leaves again, till the end of his route is reached, when the bag is given to a fresh man, who starts at once, no matter what may be the hour of day or night, and regardless of winds, rain, heat, or cold, until he too has completed his service, and handed the parcel over to a third messenger, and thus it reaches its destination. For short distances, and in all the central and sauthern parts of China, the messenger travels on foot at a rapid rate. The Taotai Sheng, at Chefoo, lately offered prizes for the four best essays on "How to establish a Chinese Imperial Post-office." There were some fifty competitors, and the prizes were duly delivered. Some of the essayists proposed the enlargement of the courier system, others the use of the offices and *employés* of the telegraph companies where they exist, and others submitted plans closely modelled upon Western systems. One argument for the establishment of a Government system was based on the large revenue to be secured that now goes into the hands of the French, English, American, Japanese, and German postal agents at the treaty ports. There are two kinds of stamps known among dealers as Chinese stamps. The first of these was introduced by Sir Robert Hart, and is used only in the Customs service. The other is a local Shanghai stamp used by a company carrying letters about the city of Shanghai, and to outposts where there are foreign Consuls, chiefly on the Yangtze River, and to the ports of Ningo and Fuchan in the south, and Chefoo, Tien-Tsin, and Peking in the north. These two systems are entirely in the hands of foreigners. Letters of foreigners are conveyed from China to other nations by the postal systems of the several countries, all Consuls being regarded as postmasters for their own countries. Letters may be sent to and from China by the use of the stamps of any country through their respective Consuls, but are only available at treaty ports. Foreigners living in the interior or away from treaty ports must make arrangements for getting their letters from the nearest Consul, or authorise some Chinese letter shop to transmit letters for them.

General Notes.

Photographic Salon.—An exhibition of photographic pictures, to be called the Photographic Salon, will be held at the Dudley Gallery, Piccadilly, from October 9 to November 11 next. The aim of the organisers, the prospectus states, is "to inaugurate a series of exhibitions (which, it is hoped, may be annual ones), bringing before the public the best productions of photography solely from the pictorial point of view." There will be no awards and no charges to exhibitors. Foreign as well as English photography will be represented. The address of the Secretary of the Organising Committee is 215, Shaftesbury-avenue, W.C.

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FRIDAY, AUGUST 4, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

MULREADY PRIZE.

The Council of the Society of Arts, acting on the recommendation of the Department of Science and Art, have awarded the prize offered by the Society under the Mulready Trust for competition among students of the Schools of Art in the United Kingdom for a drawing from the nude living model to

William J. Smith, of the School of Art, Leicester, who has most completely complied with the conditions of the offer, and has obtained the following awards in the National Competition :—

a. Bronze medal for a finished drawing from the nude living model.

b. Gold medal for a set of time studies from the nude living model.

c. Gold medal for a set of studies of hands and feet from the living model.

d. Queen's prize for a drawing from the living model done at the examination on May 11, 1893.

The Society's prize consists of a gold medal or a sum of £20, and was offered under the following conditions.

To the student who obtains the highest awards in the following subjects :—

a. A finished drawing of imperial size from the nude living model.

b. A set of time studies from the nude living model (mounted on imperial size mounts).

c. A set of studies of hands and feet from the living model (mounted on imperial size mounts).

d. Drawing from the life done at the examination on May 11, 1893.

No student is eligible for the award who does not pass in the examination (*d*) in drawing from the life, and who does not obtain an award for (*a*) the finished drawing of imperial size from the nude living model. The other two subjects are optional.

The works must be those of the previous school year.

The drawings, &c., were submitted, with other school works, in the usual manner to the Department of Science and Art, in April, 1893.

STOCK PRIZE.

The Council of the Society of Arts, acting on the recommendation of the Department of Science and Art, have awarded the prize offered by the Society under the Stock Trust for competition among students of the Schools of Art in the United Kingdom, for a design for architectural decoration, to

William Amor Fenn, of the Goldsmiths' Institute, New-cross, S.E., for his design for the decoration of the hall of a private mansion.

Mr. Fenn's design, for which a silver medal was awarded in the National Competition, consists of eight drawings, viz. :—

1. Coloured drawing to scale, side elevation.
2. ,, ,, ,, ,, end ,,
3. Plan.
4. Details of Sgraffito (coloured).
5. Mosaic Floor (coloured).

6, 7, 8. Details—fire grate, lamp, and gallery railings.

The prize consists of the Society's Gold Medal or a sum of £20, and was offered under the following conditions :—

For the best original designs for an architectural decoration, to be carried out in any or all of the following processes, *e.g.*, painting, stucco, carving, mosaic, or any other process.

This architectural decoration to be either for the side of a room, or a hall, a ceiling, or the apse or side of the chancel of a church, or any suitable part of the interior of a building.

The designs must be on imperial sheets. Each set to consist at least of a coloured drawing to scale of the whole design of decoration, and two coloured drawings of details on separate imperial sheets. Mere patterns or sketches of details, without the mouldings or borders necessary to make up a complete decorative scheme, not taken into consideration. The designs must have been made during the previous school year.

The designs were submitted, with other school work, in the usual manner, to the Department of Science and Art, in April, 1893.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Monday, July 31. Present: Sir Richard Webster, Q.C., M.P., in the chair; Sir Frederick Abel, Bart., K.C.B., D.C.L., D.Sc., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Edward Braddon, K.C.M.G., Michael Carteighe, R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, Francis Cobb, Prof. James Dewar, M.A., LL.D., F.R.S., Major-General Sir John Donnelly, K.C.B., James Dredge, Walter H. Harris, Charles Malcolm Kennedy, C.B., John Biddulph Martin, John Fletcher Moulton, Q.C., F.R.S., John O'Connor, Florence O'Driscoll, M.P., W. B. Perceval, Prof. William Chandler Roberts-Austen, C.B., F.R.S., and Sir Owen Roberts, M.A., D.C.L., F.S.A.

Proceedings of the Society.

CANTOR LECTURES.

SOME MASTERS OF ORNAMENT.

By Lewis F. Day.

Lecture IV.—Delivered May 2, 1893.

In discussing the masters of ornament, I have found it convenient to group them according to period. From towards the middle of the 17th century they form themselves, as will be seen, more than ever into groups. It is not meant by that to imply, however, that the individuality of the artist is of less account. It is the artist who determines the style of the period, even though he be himself in turn affected by it.

Style rather forms itself than is formed. And it forms itself among a people very much as it forms itself in a workshop. Those of you who are workers know how that comes about. Wherever a number of men are employed, some one of them is likely to be stronger than the rest—it is only in their mediocrity that men are equal—that stronger man strikes out a line more or less his own, and his mates take up his manner, form themselves upon it, and work in it as best they can. And so for a while he sets the style of that workshop; possibly it lingers long after he has left the shop, until there come another strong man, whose individuality asserts itself; he modifies the current style, developes it perhaps, perhaps transforms it, and his fellows follow him. The world is only a larger workshop. There too the strong men set the fashion, and the rest follow it, until there arrives another man strong enough to give it a bias in his direction. Only, as in the workshop, there are other considerations to be taken into account besides the artist—the nature of the industry in which he is engaged, the scientific and mechanical developments affecting it, the conditions of trade, and, very especially, the personality of the employer or manufacturer—so with regard to the period, the style of work depends also largely upon the state of affairs, political, social, and economical, to say nothing of the Court and the king. These are always important factors in the development of art and style.

Suppose we were to attempt to classify art some otherwise than according to style—say to classify it geographically—we should soon come round to precisely the same result; we should find that the progress of art in any particular town or district was due to the initiation of some exceptionally gifted artist, who formed a school around him, which school, under the patronage of prince, pope, doge, or, it may be, municipality, perfected and spread itself.

There were always individuals, and always will be, who are not in sympathy with their contemporaries, men born before their time, or after, men "not in the movement," as we say. But the stronger of these sway the movement in their direction, backward or forward, to one side or the other; and the weaker of them, working alone, are ineffective, and count for very much less than they would have done had there been a group of them to work together in a body. And so it comes about that, although the art of a period is essentially the art of the artists living at that time, we christen it very often after the name of the reigning sovereign, because the artists are many and the king is one, because they are more or less unknown, and there is no mistake about his identity, because, in short, it is convenient to do so, and we are lazy.

As we near the latter half of the 17th century, there is more excuse than ever for naming the style after the monarch. Louis XIII., indeed, counts personally for nothing; the influence of the Court upon art in his reign is the influence of Marie de Médicis, of Anne of

Austria, and of Richelieu—her right hand; but with Louis XIV. it was different. He was an exceptional man placed in an exceptional position.

Given a country at the zenith of its prosperity, a monarchy as absolute as could be, a monarch of immense ambition and of literally unbounded vanity: suppose that monarch to see in art a means of adding to his fame and glory, and it is clear that such a king must count for a great deal in the direction art may take under his reign. Kingship, I suppose, is calculated to give a man a vast idea of his own importance, but probably no one ever had a better opinion of himself than Louis XIV. His life, it has been said, was a perpetual apotheosis. In the contemplation of his own glory he lived, and moved, and had his being. Flattery was the very air he breathed; it could not be too rank for him; the world revolved round him; and he took it quite seriously when his courtiers likened him to the sun! Neither could the outward signs of glory be too gorgeous for him. Once, at a reception of Siamese ambassadors, he sat on a throne of silver in robes so laden with gold and precious stones that he could not bear the weight, and had to get out of them: the vanity was willing, but the flesh was weak.

No wonder, when this mighty monarch ruled in art—as he ruled in everything, supreme—art was grandiose or nothing; no wonder he bestowed his patronage on artists in proportion as they were prepared to contribute to his glory; no wonder art was devoid of anything like humour; no wonder that we have Versailles.

Versailles is the complete expression of the king, and of the style Louis XIV., so far as it represents him; but it was some time before this full and florid development was arrived at. Before that, there was a more serious, a more dignified, and a less pretentious form of design under his reign—so-called, but when it was really Mazarin who ruled. The cardinal had naturally a leaning to the art of his own country. It was he who introduced into France those Italian arts and artificers who afterwards went to form the nucleus of the Gobelins, which Colbert placed eventually under the direction of Lebrun; and one can hardly doubt that what is more sober in the earlier development of the Louis XIV. style, is due, in great measure, to the influence of the Cardinal Minister.

It is due also, in part, to an artist whom he employed, Simon Vouet. Belonging as he does strictly to the period of Louis XIII. (he lived only a few years under the regency of the Queen Mother) his design has yet so little in common with the art characteristic of the period, it is so little Flemish, so much more directly inspired by Italian Renaissance, that one must say it is with Vouet the reaction against Netherlandish art begins, and a French style forms itself once more. It is not surprising he was free from Flemish influence; he studied for fifteen years in Italy, and on his return to Paris, famous already, he naturally did not adopt the Netherlandish style in vogue but set the fashion of Italian art. Vouet was master of most of the masters of his day. He was painter, by appointment, to the king; he worked for Anne of Austria and for Richelieu, and eventually for Mazarin; and it is due to him, I take it, that the painted decoration of his time was so much lighter, more graceful, and altogether more beautiful than what was being done in wood or stone.

The panel on the screen shows very plainly the return to Italian sources of inspiration. This is a richer and more luxurious version of what Du Cerceau might have done, stronger, perhaps, in some respects, and more robust, but distinctly more modern. That is especially apparent in the treatment of the figures. Vouet makes, for the first time in French Renaissance, that abundant use of floral detail in association with more conventional scrollwork, which becomes, by and bye, a characteristic of the period of the Grand Monarque. One sees in him, too, the forerunner of Le Pautre and Berain, both of whom he seems to have influenced. He is, in fact, the precursor of the style Louis XIV.

The king found his artistic mouthpiece in Le Brun, who, in his turn, acted king over contemporary artists. But there were among them men too superior to himself in powers of design to have their individuality altogether suppressed, and we trace, accordingly, in the work with which Le Brun's name is associated a distinct difference, according as it was done by Le Pautre or by Berain.

Le Pautre is apparent in the earlier work, characterised by a certain pomp and splendour but not yet by pomposity. The first thing Le Pautre did to attract any attention, was to engrave some studies of ancient Roman work made by his master, Adam Philippon, and it is supposed that he journeyed with him to Rome. At any rate he was imbued with the Roman spirit, and something of the large style of the real Roman scroll remaining in

his own designs, and is characteristic of him. That is seen on the friezes on the screen. Certainly no one, for some generations before him, had treated the foliated scroll in so large, and even noble, a manner as he did. There is often something quite majestic about the sweep of his scrolls, which were really, what he called them, *à la Romaine*.

It was by his father's trade of cabinet-making that Le Pautre began; but under Adam Philippon he soon made himself felt, and his engraved designs had a very great influence upon contemporary work, and especially upon that of his brother Antoine, the architect.

There is not very great variety in the work of Le Pautre, but within certain limits he was facile and fertile beyond rivalry. The designs he produced were innumerable; with the aid of his son, Pierre, he published some 2,000. He adopted the old *motifs*, and used what I may call the old *properties*—stiff wreaths of laurel leaves, swags of fruit upheld by grotesques, masks, or cockle shells, and he introduced little boys, or "putti," without stint. The king liked this infant life; his instructions were, "il faut de l'enfance répandre partout." The lines of Le Pautre's architecture are not different from those of his contemporaries, only less heavy. He designed mainly for relief, for plaster, woodwork, and furniture. His work, it may be said, sums up the interior decoration of the first half of the reign.

In the second half of it, as I have said, it was Jean Berain who most influenced style. His design has not the majesty of Le Pautre's—solemnity was not in his way at all. On the contrary, his is the gaiety of the century; the lighter, the more fantastic the work, the better it suited him.

Berain worked chiefly on the flat. But it was not in his most ambitious compositions that he was happiest. His ceilings and such like are comparatively ordinary; on the other hand, his designs for costume and scenery for the opera (on which he was always more or less engaged) were fanciful, as became their purpose, and always pleasing. Indeed, in much of his ornament, of whatever kind, there is an element of the fantastical, which suggests, and not remotely, the footlights. The architecture, for example, which he introduces into his designs (if one can call it architecture) is such as one could paint, but not by any means construct; it floats more or less in the air, and belongs, in fact, entirely to the region of fancy.

Berain designed for most things in his time—furniture, faïence, iron work, tapestry, and whatever went to festive show. Subtler, freer, more sprightly than his compeers, he exercised extraordinary influence upon them—in fact, his influence on ornament was paramount with that of Le Brun himself in painting.

The post of "Dessinateur du Cabinet du Roi" suited Berain to a nicety; he was the very man for the place; he was courtier enough to fall in with every whim of his luxurious master, fanciful enough to anticipate his caprice, he was prompt to imagine, quick to carry out whatever might alleviate the boredom of the *Roi Soleil*, whose splendour burnt up, so to speak, the ordinary interest that mere mortals have in life.

But Berain, for all his artistic frivolity, had faculties of administration which recommended him no less to the practical Colbert than to the preposterous king; and so he had every opportunity of expressing himself freely and fully. The painted ornament in the Galerie d'Apollon at the Louvre is almost entirely to be attributed to him. The style of the famous pottery at Rouen (with its lambrequins and lace-like pattern) is indirectly, if not directly, his. Boulle certainly owed something to him. French Renaissance ornament was, perhaps, never more French than in Berain's hands, which is one reason, no doubt, why (for all his ability) there is little in it which appeals very strongly to the sterner British taste.

We come now to Le Brun. I have purposely deferred any mention of Ch. Le Brun because, although he was the master spirit of the period, the dictator of the arts, under whom the goldsmiths, embroiderers, bronze-workers, and others besides tapestry-weavers, worked at the Gobelins, and although he ruled over them as despotically as his master ruled him, although he represents, in a sense, most fully the period of Louis XIV., personifying, as one may say, the taste of the time, he represents, as it seems to me, rather the king than the artists of the day; and it is as the mouthpiece of the solemn pomposity of the king, rather than of the art of the 17th century, that he has real significance.

The painter who, son of a not very distinguished sculptor, could raise himself to the position occupied by Le Brun, must have been a remarkably capable man; but, so far from classing him, as some do, as the greatest decorator France has ever produced, I should say that he was the greatest administrator of decoration, and that it was by his administra-

tive faculty that he prevailed, and managed to impose himself upon his period. For my own part, I can see in his design little but swagger. The example on the screen is a very favourable sample of the kind of thing in which he indulged. I find in it a would-be strength that is only heavy, a would-be grandeur which is only grandiose, a would-be depth of colour which results only in darkness, a would-be gorgeousness which is only gaudy, a would-be regality which is royal only if we accept Louis XIV. as a type of what is kingly.

As for the detail of Le Brun's design, it is as dull as a court ceremony. But that the man was a master of administration there is no doubt. Whatever we may think of him as an artist, his ability as editor is beyond dispute. He was fortunate, of course, in his contributors. There was Le Pautre, on whom he could rely for modelling, Berain for ornament, Le Nôtre for gardening, Boulle for furniture, Claude Ballin for goldsmiths' work; yet all these, and more, he was able to hold in hand. This servant of the sun was able to pose as himself a sun, round which these brilliant luminaries moved, as though they had been lesser lights.

What a masterful man it was, to be sure! When the Galerie d'Apollon (Louis XIV. was Apollo, of course,) was to be decorated, after the fire at the Louvre, it was agreed that he should paint the pictures, and Errard (who was some 12 years or more his senior) should design the ornament. When the time came to submit their designs, lo, and behold, Le Brun had prepared a scheme for the entire work. Errard, who had confined himself to his instructions, declined, very naturally, to show his drawings, protesting that, if it was to be a case of competing for the decoration as a whole, he was quite as competent to submit a scheme for the pictures as Le Brun was to furnish one for the ornament. However, in the end, the pushing man of course prevailed. Le Brun shouldered his more modest rival out of the way, and the work was given to him; but it was Berain who did it; which is probably what Errard meant to imply when he declared that he was quite as well able to submit a design for figure subjects as Le Brun was to provide one for ornament. Errard's own style was, by the way, remarkably quiet and severe, in fact it reminds one somewhat of the "Empire" style to come.

To Le Brun we owe Versailles, a typical expression, no doubt, of over-bearing monarchy—pretentious, proud, inflated, every way excessive. It is impossible to be interested in this confusion of detail, these garlands of fruit, these horns of abundance, these trophies of war, these figures emblematic of victory, these personifications of rivers crossed by conquering armies, this cheap magnificence in gilt stucco; one has to get over the oppressive showiness of it, the boredom of it all, before one begins to recognise the art which went to all this bombast.

A great part of the furniture of the period was gilded, and in shape what the French call *bombé*, bellied out, that is to say, in large undulating lines calculated to display to most effect the gilding. The exception to this was in the case of that inlaid furniture which Boulle and his sons brought to such perfection that thenceforth inlay in brass and tortoiseshell goes by the name of "Boulle-work." As a matter of fact, Boulle did not confine himself in the least to those materials, he worked equally in ebony and pewter, for example, but the fashionable form of inlay was in brass and tortoiseshell.

André Charles Boulle was the son of a cabinet-maker, of German origin as his name implies, and he was trained in the workshop. One is not, therefore, surprised to find that his style of ornament was to some extent the outcome of the process of work he adopted. The difference between his work and that of Berain, with whom he was constantly in association, and from whose designs he sometimes worked (they were lodged together in the Louvre), is that it is peculiarly suited to inlay.

I will give you an instance of this. You know how such inlay is done. A sheet of tortoiseshell and a sheet of brass are pasted together (or several sheets of each it may be), and with a fret-saw the design is cut out; the slices of veneer are then separated, and the veneers of brass and tortoiseshell inlaid one into the other—so that out of two sheets of veneer you get two panels, the one inlaid with brass in tortoiseshell, the other inlaid with tortoiseshell in brass—"buhl" and "counter" they are called. It is obvious that, in a design made merely with a view to the pattern in brass on tortoiseshell the counterpart, with the pattern in tortoiseshell on brass, would not be very happy; and, indeed, the most ingenious designer would find it difficult to devise a pattern which came out equally well either way. But by counterchanging the effect in the design itself, and making it appear partly in brass on tortoiseshell, partly in tortoiseshell on brass, the difficulty is greatly obviated;

and we find that Boulle relied, accordingly, very much upon such counterchange in his design, and that the proceeding is, in fact, very characteristic of his work. You see it in the panel in the lower part of the piece of furniture on the screen.

Boulle's ornament has the merit of seeming always to belong to the space it occupies. If he had ever any difficulty in filling a shape, he never lets you see that it was a trouble to him. His scrolls are graceful, firmly drawn, vigorous, varied, and alive; and he has a way of correcting them by straight lines, in the form, for example, of threads of husks hanging down, which help the composition very much. Boulle's ornament always looks as if he enjoyed drawing it.

The theory that the magniloquence of the style Louis XIV. was due, in great measure, to the king, is supported by the greater sobriety of the design of Daniel Marot, a pupil of Le Pautre, who, being Protestant, found it convenient, after the revocation of the edict of Nantes, to attach himself to the court of William of Orange. He was son of Jean Marot, architect aud engraver, and is himself described as architect, though, practically, nothing is known of his architecture. He designed beds, chairs, tables, tapestries, clocks, locks, needlework, state carriages, and all kinds of furniture. Of the school of Le Pautre, he is superior to him in some respects at least. His design is less confused and more cleverly distributed, as rich, without being so pretentious, more restrained, more firmly drawn. If he be regarded as representing the foreign development of Louis XIV. (Refugee style, one French writer calls it), then the foreign version was the more sober and serious phase of the style.

The very handsome grill, or door, of forged and chiselled iron in the Louvre, of which an outline drawing is shown on the screen, recalls the Roman manner of Le Pautre. An example of Marot's pattern design occurs in the velvet with which the larger of the two chairs on the screen is covered, and shows him perhaps more himself. Marot shows a greater fondness for foliated ornament than the designers of his day generally. A Frenchman said of his design that "you can see in it that Delft was not far off." I can't say that the Dutch influence upon it is apparent to me; but perhaps one does not detect the Protestant in it.

When William of Orange came to England as king, Marot, says the historian, "followed his fortunes," by which, I suppose, we are to understand that he worked here in England; but it was not he who introduced the French style on this side the water. Charles II. had already brought it over at the Restoration.

In Germany, where, owing to the 30 years' war, there had been a gap in the continuity of design, a style much more like that of Louis le Grand was naturalised by Paul Decker, court architect to the Kurfürst of Bayreuth: Decker founded himself straight upon Le Pautre and Berain.

I have said that one characteristic of the period was the introduction among the scrollery of floral ornament, as may be seen in the work of Vouet, Berain, Boulle, and others. This naturalistic bias of the period is best illustrated in the Jean Vanquer, of Blois, who published a couple of volumes of designs, entitled respectively "A Book of Flowers" and "A Book of Vases." It is rather an evasion than a solution of the difficulty of ornamental design, to introduce vases and baskets of flowers; but it was not only under the reign of Louis XIV. that the designer has had to meet the demands of patrons (and especially lady patrons) who will have something which they call pretty, and we call "pretty pretty;" and Jean Vanquer certainly covered his spaces well, and designed his ornament on graceful lines. This is by no means the least pleasing kind of ornament that was designed at that day, and, for once, it is quite free from anything in the way of swagger. It is not precisely virile art; but when virility takes the form of bluster, one begins to think one could do very well without it, and to feel more sympathetically disposed to design that is only modest, even though it be rather lady-like.

Claude Gillot carries us into the Regency, but his best work was done under Louis XIV. He designs more or less in the manner of Berain, but he is lighter, freer, gayer, than even Berain was; his work is more open, his touch is more delicate, there is a certain airiness about his composition, he is fond of climbing and twining plants, with tendrils very often, and his foliage is even blown by the wind. We have arrived here at a more floral and more naturalistic style of ornament, but the traditions of style are still there. Gillot still means to be classical, more or less, though, as it proves, it is decidedly less. His pupil Watteau drops the pretence and is himself. But he does not improve upon ornament of his master.

Watteau was *the* painter of the Regency

and especially of the "fêtes galantes" associated with it. Perhaps it was owing to his early connection with the theatre that he was to the last so much in love with the artificial. The peasants he pourtrays, in impossible gala suits, belong to no country but the stage, they are fit only to play the flute or mandolin (with which he never fails to provide them) and not to handle the plough; the landscape he depicts is the smiling accomplice of their inveterate coquetry, his woods are painted expressly to frame their flirtations (by no means to hide them); his Olympus is a brand new one full of deities unknown to antiquity—he deifies in fact the 18th century. But, given the artificiality of Watteau's art, it all hangs together. He sugars nature plentifully, but nature, as he presents it, is invariably sweet. He is always delicate in touch and colour, always light, always graceful. I think it is De Goncourt who says his lines always smile. One is rather surprised, therefore, to find that an artist so little hampered by considerations of anything like realism should show so slight an inclination towards the ornamental. The fact appears to be that, in spite of his success, in spite of the adulation of his contemporaries (when he competed for the Prix de Rome the Academicians elected him instead at once to their illustrious body, protesting that he knew more than they already and had no need for further study), in spite of all that, Watteau was never really satisfied with himself, and had in his heart a hankering after a higher ideal of art, which, alas, he had not the self-denial to pursue. The French claim for him that he was a poet. They mistake, I think, piquancy for poetry. To judge by his performance, his muse might well have been a milliner, his deity a Dresden shepherdess. In ornament he was so far individual that he followed no master, but he was certainly none himself. With him landscape begins deliberately to be used by way of ornament or its substitute.

Contemporary with Gillot, a year older than he, in fact, is Gilles Marie Oppenort; but in him we see much more plainly the beginning of the rococo, which he lived to see fully developed. He represents, indeed, the style of the Regency—that reaction against the tyrannous etiquette, or rather that recoil from the prudery, which marked the declining years of Louis XIV., when he was under the decorous dominion of Madame de Maintenon.

The king dead, the rococo shot up. There is not really any marked difference between the style of the regency of Philippe d'Orleans and the style of Louis XV., only the initiators of the emancipated manner did not push it to the extreme to which it was afterwards carried. But it is already so little restrained that one has to seek in their work the evidence of restraint. Oppenort may be looked upon, anyway, as the father of the rococo; he showed the way, if he did not follow it out to the end, and, as he furnished designs for all the arts and industries, he is responsible for a good deal.

The example to the right of the screen, the title-page to his third book, is a more than favourable specimen of his work; but if you examine it you will find that the only really interesting thing in it is the graceful figure group; the rest is purposeless and foolish enough.

With Oppenort should be mentioned Robert de Cotte, the architect of the Grand Trianon, to whom we owe the bright idea of introducing looking-glass by way of panel decoration, and of painting ceilings a dead white, a brace of devices which may be described as, not so much ornament as the negation of it.

Another important person was Charles Cressent, *ébéniste* to the Regent, whose *appliqué* bronze work was wonderful in its way, but it was hardly the way of ornament. The art of the period, by the way, was, in one sense at least, strictly "applied" art—it was to a great extent stuck on, whether in shape of gilt compo in decoration, or of ormolu accessories to costly furniture.

The long panel on the left of the screen is by François de Cuvilliés. He was a pupil of de Cotte, and it was by the all-powerful agency of his master that he was appointed architect to the Elector of Bavaria, in whose service he spent his life. The shapeless forms which there do duty for ornamental detail, are quite characteristic of the full-blown period, but still the idea of symmetry has not yet been abandoned; the cartouche at the top, for example, is not yet all askew; this is not by any means the last word of the rococo.

We have arrived, indeed, at that absolutely capricious ornament, so called, representing a kind of mis-shapen shellwork or rockwork, encrusting and deforming everything, which one sees rampant, for example, in Dresden china, in which it may well have had its origin. (Our own Chelsea china, so dear to the collector, is equally monstrous in design.) But the horror of the "Rocaille," as this is called, is not complete without that element of the unsymmetric which Meissonnier brought to its fulfilment, and which really constitutes

the baroque. The term *baroque* is applied, in the first place, to a pearl that is not round, especially to those eccentrically shaped pearls, which it was the fashion to mount in the form of fantastic and extravagant jewellery—as you may see in the green vaults at Dresden, where a number of such things are preserved, for no useful purpose but to show the depravity of taste that once prevailed in high places.

The word baroque, then, is used to express that extravagance of shape which soon became the rage. I am sorry to have to use such outlandish words as rococo, rocaille, baroque, but there seems no way out of it, but language itself must be tortured to describe the wild vagaries of 18th century art.

At the head and front of this offending is Just Aurèle Meissonnier, who more than anyone contributed to the *bizarrerie* of the period. Never was anything like the orgie of licentious form in which he indulged. He would have done away with the straight line, had it been possible; as it was, he avoided it as if it had been truth, and, where he had to use it, broke it as often as he could. Cochin, a contemporary artist, makes good fun of his "walls which bulge about so recklessly, it is only by a miracle they keep their balance; his mouldings, which are so accommodating as to roll themselves up, if so be it suit his purposes; his cornices, which have to bend themselves into the most eccentric shapes; his balconies and stair-rails, which are no longer allowed to go straight about their business, but are compelled to wind about according to his will." No material, he said, was so rigid but in his hands it must be supple; it must wriggle to the tune it pleases Meissonnier to play. As the letter S is the nearest approach he will allow to a straight line, so the fiddle-shape (which had long been in favour) was, to his mind, too severe to be endured. It has actually two sides alike. He was not satisfied that the sides of a thing should undulate, he would have the waving lines eccentric also; it is a foregone conclusion with him that they shall never actually balance. So far from his desiring that there should be any correspondence between right and left, he would have it a race between them, as to which should get farthest away from the straight line which common sense would have suggested.

Some of his ornament has very much the appearance as though it had been thrown on to the panel, and had not been thrown straight. At times, his scroll-work breaks out into waves. There are breakers of ornament at the back of the settee on the screen, and in the epergne above there are wave-forms, inspired, apparently, by Japanese bronze casting; but the Japanese make a better thing, even of their unruly waves, than that.

The artists of the rococo were aiming always at the unexpected, until at last that is precisely what one expects of them; it ceases to be a surprise and only bores us.

In his designs for silversmiths' work Meissonnier shows another side of his genius for going wrong. We are so accustomed to "still life" in silversmiths' work in lieu of beauty of form, that we look upon it almost as in the nature of things, and forget that this particular form of vulgarity is an innovation upon more ancient and more dignified design. Meissonnier was one of the prime innovators; he conceived it to be a very happy thought to model sticks of celery by way of feet for a tureen, or artichokes to serve as handles; and he published a whole book of designs of this cheap Brummagem description, about which again Cochin chaffs him, as also for the way in which he neglects, in his design, to take into account the very use and purpose of the thing he is designing. "Really," suggests his critic, "a candlestick ought to be straight and straight up, to support the light, not twisted as though someone had wrung it;" "a *bobêche*," he remarks, "should be concave to catch the candle drippings and not convex to shed the grease carefully over the candlestick," and so on—to which a modern apologist for the rococo replies, that decidedly Cochin did not grasp the genius of the great man, who would have been only too sorry if the candles had not dripped, for their capricious and soft cascades have unctious curves which form a natural decoration admirably in keeping with the rocaille! It is difficult for an Englishman to imagine that that is not said in irony, but anyway it indicates the kind of thing which passed once for ornament.

Meissonnier, it is said, founded himself upon the Italian Francesco Borromini, who (in his mad jealousy of the more famous Bernini) stopped short at no excess which might serve to advertise him; and, as he had some invention, he succeeded in making himself rather ridiculous. So, to my thinking, does Meissonnier, who was at the best "an artist in extravagance," as a journalist said the other day of an American music-hall dancer. But even in extravagance there were artists far more consummate—for example,

Filippo Passarini, some of whose work I show you; in point of time, he comes between Borromini and Meissonnier; he died, in fact, in 1700.

Passarini seems to me to succeed in doing what the Frenchman only aimed at. This work of his may be loose, luxurious, exuberant, riotous, wanting in restraint and repose, but there is design in it; it grows, and grows vigorously, it is not chucked together; and, for those who can stomach something very rich, it is not without a kind of dignity. By the side of that, the French rocaille is mere effort. Comparing this largely designed and living scrollery with the abortive palm leaves which do duty for acanthus in the French work, with its endive-like vegetation, with its froth-like lines, one begins to doubt whether Meissonnier was, after all, even an artist in extravagance!

Less extravagant, and far more artistic, was his contemporary, Pierre Germain, the famous silversmith. He was of his time, but, compared to Meissonnier (who put him rather out of fashion) his design is almost simple. His lines are firm and nervous, and *he* gets some grace, and even some severity of shape; and his shell-work does almost seem to grow sometimes.

A more elegant, if always a very frivolous, side of French art was represented by such men as Jean Pillement (with his chinoiseries, which were all the fashion) and Boucher (who may be considered as the successor to Watteau).

This, it must be borne in mind, was the period of paint and powder, patches and perfumery. Healthy or manly art was hardly to be expected. What did thrive was a rather pretty, piquante, but mannered style of art, well suited to the frail boudoir of the period, an art in which Boucher was born to excel.

The designs he furnished to the tapestry weavers of Beauvais and the Gobelins were much what he might have painted upon a fan. It was decoration in miniature—gay, both in design and colour, but frivolous always—trifling more or less exquisite, but, at the best, trifling. Beauty is a height it could never reach; its highest point is prettiness.

Madame de Pompadour found in Boucher her painter ready made. He fitted her precisely—expressed her—her tastes, her caprice, her reign, in short. His work was without distinction or style, and without a vestige of poetry, but it was French: the man was Parisian to the finger tips, and was popular accordingly. The only voice uplifted against his fame was that of Diderot, who did protest that his taste was degraded. And it must be allowed that the art of the period of Louis XV. was as low as the Court it was its poor ambition to serve. In its very elegance there was a sort of rowdiness; in its very delicacy, a suspicion of viciousness. Anything less in accord with the idea of serious and sober citizenship it is impossible to conceive; yet it is just this sickly-sensuous, nerveless form of art that some fashionable upholsterers of to-day are recommending us to adopt. That is my excuse for so many words on what, on its own merits, is worth so little serious consideration.

M. Ménard, a distinguished professor at the Ecole des Arts Decoratifs, says that the French of the 18th century studied the work of earlier periods, not to reproduce it, but by way of a sort of healthy gymnastic exercise of the inventive faculties. So far so good. That is precisely what they should have done, if they did not always do it. Nothing could well be wholesomer than such exercise, so far as it goes; but few of them, unfortunately, seem to get much further than the exercises; and not a few gave themselves up to the indulgence in gymnastics which had not the remotest reference to any serious period of art whatever.

It was about the middle of the 18th century, when things were at their worst, and some few men of taste, such as Cochin, Sufflot, and the Abbé Leblanc were doing their best to turn the tide of fashion in the direction of more temperate design, that the Ruins of Pompeii were discovered, and attention was called for the moment to Classic art. That was their opportunity. Interest in the subject was not allowed to die out. The public were reminded that some five and forty years before (1713), Herculaneum had been discovered; forthwith a great work on the subject was projected, and within a couple of years its publication was commenced; that was in 1757; and there arose a demand, or at all events a market, for a style of design bearing some remote relation to the antique. This severer style ran for some time side by side with the manner more characteristic of the reign of Louis XV.; eventually it superseded it, and became known as the style of Louis XVI. Perhaps it might more fitly be called the style of Marie Antoinette; as the style of Louis XV. might justly go by the name of the Du Barry.

The style (Louis XVI.) is at best a feminine version of the masculine antique, but it is at least worthy of a lady's boudoir—and there is

sometimes even a certain freshness and girlishness about its grace and gladness. Its sentiment, too, is rather young, with its bows and quivers of arrows, cooing turtle doves, love's torches, garlands, and true lover's knots. The great charm of it is its delicacy, it shrinks from any violence of line or colour; the favourite framing shape is the oval, the favourite shade of colour grey-green or celadon, and the brighter tints employed are mostly pale and pure; gold itself is mat; modelling is usually in very low relief, more like cameo-carving sometimes; mouldings are of very slight projection, whilst the details of ornament are often carved with a tenderness and subtlety which excuses the minuteness of the work. Foliage is consistently trained somewhat in the way it should go; the scroll, though small in scale and rather thin, is mostly graceful; and, together with the slight wreaths and bunches of natural flowers which mostly accompany them, and with suspended strings of beads or pearls and fluttering ribbons, they always occupy, however lightly, the space they are designed to ornament. And that space is bounded most often by straight lines once again.

One of the happiest, as it is one of the most characteristic features of the style, is the way in which (whether for framework of furniture or architecture) the straight line is everywhere employed, in combination with ornamental detail as freely designed and as lightly touched-in as it is possible to imagine.

And it must be confessed that one welcomes the straight line itself, so long banished from design, and now at last "restored to its own again"—the legitimate line, a loyalist might say—the line, at all events, which rules, by right of common sense, in furniture no less than in architecture.

A prolific designer of the period is Jean Charles Delafosse, architect, decorator, and professor of design (we have arrived at an academic period now); but Delafosse does not fairly represent the style. He designs with a rather heavy hand. Classicism appears to hamper him somewhat, and he does not move easily under its restraint.

The first to express himself freely and spontaneously in the new manner is Gille-Paul Cauvet, a designer and sculptor of Aix, who naturally gravitated to Paris.

It is possible to illustrate only one phase of his art. The panel selected shows something of the serene and graceful composition which comes as such a relief, after the at best rollicking elegance of the past style. There is here more reticence, more quiet, more simple grace than in anything that had been done for some time past. The design is open, without being empty at all. There is just severity enough of line in it to show that the artist had a care for ordered form; and yet it is not too severe for the decoration even of a drawing-room, where it seems to be a foregone conclusion that decoration should be rather frivolous.

It is not pretended that the delicate and dainty composition before you aspires to a seriousness which would have been fatal to its favourable acceptance in the eyes of the 18th century patron of art. The figure portion of Cauvet's work was admirable, but he was one of the few who could deny himself the luxury of the human form, on occasion, and design pure arabesque. Indeed he is responsible for the design and carving of some of the most graceful arabesque of the time, a lighter Roman scroll with a grace all French, and perhaps a little French frippery added. He ranks as a sculptor of ornament, and his work is essentially ornamental. He was a chaser too; but the most famous chaser of the period when chasing was at its best was of course Gouthière, who worked with the equally famous Riesener, the cabinetmaker—one of those who from having begun work in the manner more or less of the earlier reign, mended his ways betimes, and became in turn a typical exponent of the more chastened style, and produced, under the patronage of Marie Antoinette, quite the most wonderful specimens ever produced of a class of furniture designed for ornament rather than for use. The specimen of Gouthière's work there on the screen gives, much better than in the last illustration shown, the delicacy of detail in which the charm of such work very largely consists—in fact unless a man have grace at his fingertips it is hopeless to attempt it.

Those who most admire such work, and those who least admire it, might express their appreciation of it in identically the same words, and say it is the glorification of finish. On the lips of the *dilettante* that would be the highest praise; on other lips it would imply a reproof to the artist who had mistaken the mere means of expression as an end worthy in itself of an artist's whole devotion. From the merely practical point of view, it may safely be said, that in work of this kind we get the minimum of decorative effect at the maximum expenditure of time and labour and artistic skill; but there

is room for art of that kind too, if only as a protest against cheap effect.

The dryer and harder manner of the time is illustrated in the design of Clement Pierre Marillier. There is a certain rigidity, a heaviness about the compositions on the screen. which goes to explain (what from the work of Cauvet and Gouthière would not be intelligible) the complaint of some French critics that the style Louis XVI. was frigidly severe. There *is* here a sort of Puritanical formality of design, which is neither inspired nor inspiriting. But I confess myself puritan enough to prefer it, even so, to the riot of the rococo.

Marillier illustrates, by the way, a tendency of the time (and of all times, more or less, I am afraid) to overweight ornament with meaning. Artists (or their patrons probably) insisted too much upon symbolism, usually of a sentimental kind; and so we have lyres, urns, torches, and other emblems, to say nothing of emblematic figures, which have not even intrinsic interest to justify their intrusion in the place of ornament.

That Le Nôtre and his *confrère*, La Quintinie, whose medallions are there framed in ornament, were famous gardeners, accounts, of course, for the orange tree in its box, and the rose and other bush in the pots at the side; for the trellis-work, the vegetables, the rake, and other garden tools; but it does not make them ornamental; and one feels very strongly that beauty has been sacrificed to a very cheap sort of symbolism. The Philistine who clamours for the introduction of this, that, and the other thing into a design, is to be excused on the score of his ignorance; he does not know at what cost of art they are introduced. The designer should know better, and if he is really an ornamentist he will admit into his composition (except upon compulsion) only that which he can turn to ornamental account.

An artist more typical of his time is De Lalonde, whom I refrain from illustrating only because any one of his designs would give a very false impression of him. At his best he is a most graceful and accomplished exponent of the style Louis XVI. At his ordinary level he is a fertile inventor of, on the whole, tasteful (but not more than tasteful) trifles, seldom much above the dignity of a snuff-box.

One other facile designer remains to be mentioned, Salembier, who "turned out" a great deal of work. He designed for the factories of Lyons, and published a vast number of designs for friezes, arabesques, vases, and all kinds of ornament. Salembier is not a model of restraint; his design is looser than that of the best men; it does not even confine itself to one plane, but aims, very obviously sometimes, at a certain sort of perspective, as may plainly be seen in the lowermost of the three friezes on the screen.

That is not, in my opinion, precisely the thing to do, but it is done with the skill of a master; and, indeed, the charm of such work is in the ease with which it is done. It is very easy to do that kind of thing indifferently, but it takes an artist of more than ordinary facility to do it at all well. It is only by dint of much hard work that a man buys freedom of hand like that. Salembier's designs are slight, but they are graceful enough to make it hard to equal them in their admittedly not ambitious way.

Other distinguished ornamentists of the period were—Ranson, a decorative painter who distinguished himself especially by his taste and skill in the composition of ornament more distinctly floral; Prieur, designer and chaser to the king; and Fay, a designer and engraver, who worked more or less with him.

The revival in Italy was rather more severely classical. Among Italian masters of the period are—Piranesi, with his 29 folio volumes of engravings, mere copies from the antique; Albertolli, who, from being a sort of drawing-master's authority a generation or so ago, has slipped into a sort of oblivion he does not entirely deserve; Pergolese, the sculptor, and Bartolozzi, the engraver, both of whom migrated to England and worked for the brothers Adam.

With the Revolution there came a marked change over the spirit of French art. Classicism still prevailed—prevailed, indeed, more than ever; for the affectation of the antique, from having been a merely fashionable foible or caprice, became now almost a solemn duty. Was it not, in a sort, the outward and visible sign of republicanism and good citizenship?

The source of inspiration is, however, no longer the same. Not pleasure-loving Pompeii but Rome is now the fountain-head, stern republican Rome, type of good government as well as mistress of art.

There is an almost Puritan formality about the ornament of the period, which we call by the name of the "Empire," but which really is the period of the Revolution. There is a coldness about it, such as we find in the paintings of Louis David, active revolutionist, and, as such, arbiter, for a time, of French taste.

It would seem as if grace itself, from its

sometime association with a hated *régime*, had become *suspecte*; and whatever was not heavy, stiff, austere, was deemed beneath the dignity of art, which had now no excuse, unless it were civic.

What remained of graciousness in the art of the Revolution is due, mainly, to Pierre Prudhon, who, we may say, sums up the *neo grec* of Louis XVI. The nymphs and cupids he designed are still tender and charming, endowed with a grace of other and less anxious days; but it is significant of the times, that even Prudhon and Percier (who ranks next to him as a designer) were among those who signed a report advising the destruction of some hundreds of designs belonging to the national manufactures, on the score of anti-revolutionary and immoral tendency.

It was further forbidden by law to introduce into carpet design the human figure. The human form divine was not to be trampled underfoot. Moral and artistic propriety were for once in accord.

Percier, and his associate Fontaine, were the decorators most in demand under the Empire. The character of their work is in the main rigid; the straight line and circle prevail; symbolism is more in favour than ever; but they are civic emblems that are used now, oak and laurel wreaths or attributes of war; the Roman eagle broods over all; and, after the expedition to Egypt, sphynxes, and other Egyptian symbols are used—symbolic no longer, except of the campaign. It is all monotonous enough, pedantic as philosophy, and cold as patriotism, but it has character and dignity.

I have dwelt at some length on the French styles (at much greater length proportionately than the work itself deserves) because there has been of late, and still seems to be, a demand for design in the manner of the periods of the later Louis; and if a man must work in a given style, it is as well he should found himself upon the best that is in that style—upon its masters, and not upon the common run of work that was not even good of its kind. But conscience compels me to add one word of protest.

No man is probably so absolutely at the discretion of the public demand as he thinks himself to be. The hardest taskmaster will scarcely refuse *better* work than he asks of you, if you choose to do it. Do it, I say, for your own satisfaction. If you do not, if that is not inducement enough for you, well then, perhaps you are not so much an artist as you think yourself.

One thing is certain: art asks some sacrifice of her worshippers, and all artists make sacrifice, and make it cheerfully. Do not suppose I advise any one to quarrel with his bread and butter; but if he is greedy about the butter, and especially if he cannot do without jam, it is a sure sign that his artistic appetite is not in a healthy state.

Further than that, I doubt if it be to a good workman's interest—even in the narrowest sense, I doubt if it be to the interest of his pocket—to be too absolutely the slave of any one: and especially I doubt the wisdom, as I doubt the courage, of the Englishman who succumbs without a fight, and a good fight, to the demand for French styles of art. Establish the French styles in England, and all who want good work will go to France for it, for the obvious reason that at Louis XV. or Louis XVI. the Frenchman can give us points, and thrash us, whereas on our own ground we can beat him; or, if that be not so certain, it is only on our own ground that we have any chance of thrashing him. To adopt French styles is to play into the hands of foreign competition. It is to our interest, as it should be to our pleasure, to make our work our own; and, being that, 'twill not be French at all events.

No one I hope will go away with the idea that, in bringing before you in this course of Cantor lectures the work of "Some Masters of Ornament," I would suggest that any man should deliberately found himself upon them, still less that he should confine himself to the imitation of what they actually did. It is mainly for inspiration that we must look to them. The student may find *his* master among them, or he may not. Anyway it can do him no harm to know what has been done, even though he should have no sympathy with it.

I would have every man, once full-grown, go his own way in art; but I would have him follow it with his eyes open, and not blindly. The danger of independence is when it is founded upon ignorance. I would have a man dare, but I would have him dare knowingly.

General Notes.

ANTWERP INTERNATIONAL EXHIBITION, 1894.—Further information respecting this Exhibition, to be held from May to November, 1894 (see *ante* p. 575), has been received from the Foreign-office. All communications respecting the Exhibition are to be addressed to the Executive Committee, 9, Rue Gerard, Antwerp.

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FRIDAY, AUGUST 11, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

PRIZES FOR DESIGNS FOR FURNITURE.

The Council of the Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the Memorial Committee, on condition of their spending the interest thereof in prizes to "Students of the Schools of Art, who in annual competition produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damasks, Chintzes-&c., regulated by the principles laid down by Owen Jones."

The prizes will be awarded on the results of the Annual Competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

No candidate who has gained one of the above prizes can again take part in the competition.

The next award will be made in 1894, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones's "Principles of Design," and the Society's Bronze Medal.

Chicago Exhibition, 1893.

BRITISH JUDGES.

The following is a list of the Judges in the various departments of the Exhibition appointed by the Royal Commission (see *ante* p. 769). Information has been received from the Secretary, Sir Henry Trueman Wood, that the work of the Judges has now commenced.

AGRICULTURE.

Food—Richard Bannister, F.I.C., F.C.S.; Adam Brown (Jamaica); H. Vincent (Trinidad).

LIVE STOCK.

James Weir (Lanark, N.B.).

HORTICULTURE.

George Nicholson, A.L.S., Curator of the Royal Gardens, Kew.
Orchids—C. F. Sanders (St. Albans).

FISHERIES.

W. S. Letten (Grimsby).

MINING.

Prof. C. Le Neve Foster, D.Sc., F.R.S.; Hilary Bauerman, F.G.S.

MACHINERY.

Prof. W. Cawthorne Unwin, F.R.S.

TRANSPORTATION.

Shipping.—Prof. Francis Elgar, LL.D.
Road Carriages.—George H. Thrupp.
Ordnance.—Capt. Orde Browne (Woolwich).

MANUFACTURES.

Woollens.—George Thomson (Huddersfield).
Linens.—Thomas Hanna (Lurgan).
Cutlery. — John F. Atkinson, Master Cutler, Sheffield.
Leather.—John H. Angus.
Pottery.—Francis R. Jones (Stoke-on-Trent).

LIBERAL ARTS.

Education.—Dr. O'Reilly.
Instruments of Precision.—Prof. Silvanus P. Thompson, D.Sc., F.R.S.
Civil Engineering.—Urban H. Broughton.
Scientific Apparatus.—Prof. John Milne, F.R.S.
Sanitation.—George Shaw.
Surgery and Medicine.—Ernest Hart.

ELECTRICITY.

Prof. W. E. Ayrton, F.R.S.
Prof. George Forbes, M.A., F.R.S.

FINE ARTS.

Painting.—H. W. B. Davis, R.A.
Val. C. Prinsep, R.A.
Water-colours.—Alfred W. Hunt, R.W.S.
Black and White.—Frank Short, R.P.E.
Architecture.—William Emerson, F.R.I.B.A.
Sculpture.—Thomas Brock, R.A.

WOMEN'S WORK.

Philanthropy.—Mrs. McCullum.
Handicrafts.—Mrs. Crawford.
Nursing, Hygiene.—Miss Kenealy.

Proceedings of the Society.

CANTOR LECTURES.

THE PRACTICAL MEASUREMENT OF ALTERNATING ELECTRIC CURRENTS.

By Prof. J. A. Fleming, M.A., D.Sc., F.R.S.

Lecture I.—Delivered January 30th, 1893.

The Measurement of Alternating Current Strength.

The subject on which I have undertaken to speak to you, in this and three succeeding lectures, is the practical measurement of alternating electric currents. The limits of time at our disposal will not permit me to deal with the question of electric measurements in general, far less to discuss the elementary principles on which all such measurements depend. I shall take it for granted that you are, at any rate, familiar with the fundamental facts concerning the production of electric currents, and most, if not all of you, familiar with the processes and instruments used in the measurement of continuous or unvarying currents.

The measurement of alternating or periodic currents involves processes and ideas which are somewhat more difficult to master than the simple conceptions which are sufficient to guide us in dealing with unvarying currents. It is towards the elucidation of these special difficulties that these lectures will be directed; and, keeping in view the special requirements of practical engineers dealing with alternating currents, I shall address myself entirely to the practical question of measurement, leaving out of account altogether theoretical matters. The practical measurement of alternating currents is a very important subject, because probably by far the larger portion of the electric lighting of the world is now conducted with alternating currents, and some of the largest schemes of transmission of power that are in process of development or already completed are being carried out by means of alternating currents.

Our first duty will be to begin with some familiar definitions which will make clear the meaning of the terms to be employed. When a conductor is traversed by an electric current we know that certain physical effects are produced. We know nothing about the real nature of an electric current. All that we can do is to measure the degree or amount of the physical effects it produces. Two of these effects are at once evident on very simple investigation, namely, that the current heats the conductor and produces around it a magnetic field. The moment we begin to investigate these effects we find that the electric current may be either in a variable state in which progressive changes are taking place in the effects produced by that current, or it may be a steady or unvarying condition in which the effects remain constant; or it may give evidence of being periodic in its nature, that is to say, the electric current may vary in strength and in direction in a periodic manner. When any cycle of operations takes place in such a way that any given effect runs through a series of changes, we speak of the periodic time of that effect, meaning by that term the time in which the whole cycle of operations is completed. Also we speak of the frequency of the change, meaning by that term the number of cycles completed in a second. A familiar illustration of the use of these terms may be drawn from music. In the case of a musical sound, the string, or the air in the pipe runs through a certain cycle of movement, and the periodic time of the note is the time of completion of one complete vibration of the string or of the particles of the air; the frequency is the number of complete vibrations per second. The middle C of the piano has, or may have, a frequency of 256, the octave below that 128, the octave below that 64. In the case of electric currents which are periodic, the strength of the electric current is changing from instant to instant, and it is periodically reversed in direction. Applying the above terms, we speak of the frequency of the current meaning the number of complete cycles in a second. For instance, the alternating current supplied to this lecture-room from Deptford, has a frequency of about 84, which corresponds to the lower F on the bass clef. The currents employed in the electric lighting of Rome are about an octave lower, namely, 40 in frequency.

You may picture to yourselves the difference between a continuous and an alternating current as similar to the difference between a non-tidal and a tidal river. In the case of a non-tidal river the waters flow on always in one direction—down the river; but in the case of a tidal river, such as the Thames at London-bridge, the direction of the flow of the water is periodically reversed. When we are dealing with periodic currents, or periodic electromotive forces, it is very convenient to repre-

sent these by means of current curves, or electromotive force curves. To do this we take a horizontal line to represent the periodic time of the current, and dividing this line into a number of small equal parts, we erect perpendiculars at each point, proportional to the strength of the current, or to the electromotive force at that instant; joining the tops of these lines by a curve, we have an electromotive force or current curve. We then may speak of the instantaneous value of the current or electromotive force, meaning thereby the value it has at any instant; or we may speak of the mean value of the current or electromotive force, meaning thereby the average value which it has during the period. It is also necessary to consider another, a rather more complicated kind of average, which is called the square root of the mean square value. This is obtained by taking the mean of the squares of all the instantaneous values taken at the equidistant intervals during the period, and then taking the square root of this mean value. To avoid constant repetition of this cumbersome phrase, the square root of the mean of the squares of the equidistant values during the period, we shall call it shortly the $\sqrt{\text{mean-square}}$ value of the current or electromotive force.

Presently we shall see why it is that certain instruments give us this $\sqrt{\text{mean}}$-square value. It is important, sometimes, to be able to draw these current curves for any alternating current, and this has been done by many observers, notably by Duncan, Ryan, and Hopkinson.

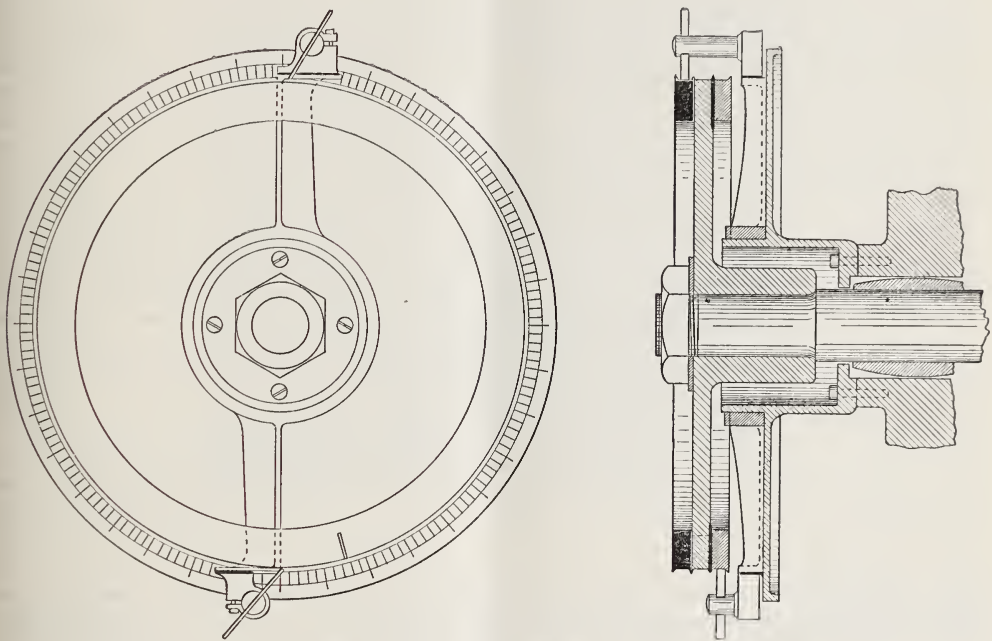

FIG. 1.

In Fig. 1 we have a diagram of an apparatus used for this purpose by Dr. Hopkinson. On the shaft of an alternator is placed an ebonite disc, having at one point on its circumference a narrow feather of brass laid in. As the ebonite disc is carried round by the machine, the brass edge is made to complete the circuit between two metallic brushes, which press against the ebonite disc, and the instant when this occurs can be determined by varying the position of the brushes. By connecting an electrometer with these brushes in the manner shown in Fig. 2, the electrometer gives us the measure by its deflection of the instantaneous value of the electromotive force of the machine

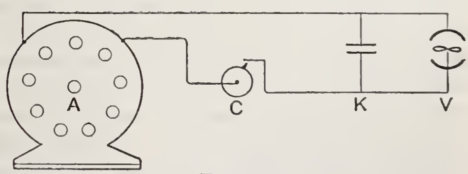

FIG. 2.

at that one particular instant. By shifting the position of the brushes we can measure the electromotive force at equidistant intervals

during the period, and then plot out the electromotive force curve. In the same way, by measuring the instantaneous value of the potential difference between the ends of the resistance traversed by an alternating current, we can delineate the form of the current curve for that particular current.

In Fig. 3 are shown electromotive force and current curves for a particular alternator, and, it will be seen, that they are highly irregular curves. We have, in the next place, to understand what it is that we are able in general to measure in dealing with alternating currents. When the alternating current flows through a wire, we may, by means of the instrument above described, determine the instantaneous values of that current. But this is not what, in general, we wish to do, neither are we much concerned with the true mean value of that alternating current. In by far the larger number of cases, the only thing that we want to know, and the only thing that we are able to measure, is the $\sqrt{\text{mean-square}}$ value above explained.

When an electric current flows through a wire it heats it, and the rate of production of heat is any instant proportional to the square of the current strength. Hence, if the current strength is changing from instant to instant, the total quantity of heat produced in the wire in any given time is proportional to the mean of the square of the current strength. Under fixed conditions, the temperature which the wire will assume will depend upon this mean

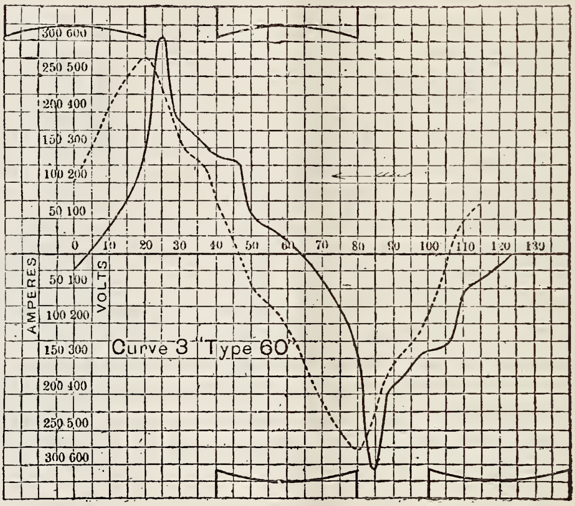

Fig. 3.

square value of the current; for the wire attains its final temperature when there is a balance between the rate at which the heat generated in it and the rate at which the heat has lost by it. The wire loses heat in three ways—by convection, by radiation, and by conduction. If a wire is enclosed in a tube in such a way that convection is prevented, then the wire attains a final state of temperature, when there is a balance between the rate at which the wire loses heat by radiation, and gains it by internal generation. Under these conditions, the temperature, and therefore the length of the wire, is determined, not by the average, but by the mean square of the current strength. If, therefore, the current is an alternating current, the final temperature and therefore the length of the wire enables us to measure this mean square value of the current. In the same way if two conductors, one of which is fixed, and the other movable, are traversed by the same electric current, the electro-dynamic repulsion or attraction between these two conductors, due to the magnetic field around them, becomes a measure of the same mean square value of the current, for at any instant the stress between the conductors is proportional to the square of the current strength flowing through them, and if the current is varying from moment to moment the average value of this stress is a measure of the mean of the square of the current strength. We may therefore employ either of these two physical effects, the heating of a

wire by a current, or the mutual stress between two conductors traversed by the same current, to measure the mean square value of that periodic current.

So much being understood, it is now possible to point out to you what we mean by an alternating current of one ampère. A continuous current of one ampère has been defined by the Board of Trade Committee as an unvarying current of electricity which, when passed through a solution of silver salt, deposits ·001118 gramme of silver per second, or 4·0248 grammes per hour. This may be taken as the practical definition of what is meant by an electrical current having a strength of one ampère when that current is an unvarying current. An alternating current cannot, however, be estimated by such an electro-chemical method, but it is defined as follows:—An alternating current of one ampère is understood to be a periodic current which, when passed through a conductor, brings this conductor to the same final steady temperature as an unvarying current of one ampère would do when passed through it under the same conditions. It is therefore an alternating current whose $\sqrt{\text{mean-square}}$ value is unity, assuming the instantaneous values to be measured in fractions or multiples of an ampère. Having defined our unit of alternating current, and the two particular general methods of the $\sqrt{\text{mean-square}}$ value, I may show you two experiments illustrating these facts.

Before me is an instrument, which I have designed for some other purposes, but which is practically an apparatus for the measurement of the expansion of a wire. If you look at it you will see it consists of a wooden stand, A, B (Fig. 4), having a sliding-

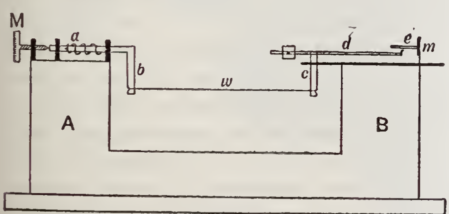

FIG. 4.

rod, *a*, at one end, pushed forward by a micrometer screw, M, and at the other end a system of levers, *c*, *d*, *e*, moving a mirror, *m*, from which a ray of light is reflected on to the screen. The micrometer rod and the system of levers are connected by a very fine copper wire, *w*, about fifteen inches long. On passing a continuous current of electricity through the wire, you see the spot of light on the screen changes its position, indicating that the wire has elongated. I can then, by means of the screw, bring the spot of light back to its old position, and thus measure the elongation of the wire, and therefore its mean temperature. Performing then the same experiment with an alternating current which is adjusted to give the same expansion to the wire, I know that I have now passing through the wire an alternating current, of which the $\sqrt{\text{mean-square}}$ value is equal to the value of the continuous current. Such a thermal instrument may be modified in many ways, and we shall presently see the forms it assumes; but in all of them the same principles are, in practice, employed.

In the next place, let me direct your attention to another apparatus, intended to illustrate the electro-dynamometer method of measuring alternating currents. An electro-dynamometer is an instrument which consists of two coils of wire, one of them fixed and the other movable. In the apparatus before you the movable coil is hung up by a steel wire. The movable coil is placed with its axis at right angles to that of the fixed coil, and when one and the same current is passed through the coils, the movable coil tends to turn round so as to place its axis in line with that of the other. But by twisting round the suspending wire we can bring the coils back to their original position, and this amount of twisting is a measure of the mean square value of the current strength flowing through the coils. If, therefore, the current varies from instant to instant, the force which is required to hold the movable coil in any given position varies as the average of the square of the strength of the periodic current. Hence by means of these instruments, as by means of the hot wire apparatus, we can measure the mean square value of the periodic current. Whilst I have this instrument before me I will point out one fact which is of practical importance. We know that if a copper plate is held in front of an alternating electromagnet it is repelled, and, similarly, if a copper plate is held near the movable coil of this dynamometer it in like manner repels the movable coil when that movable coil is traversed by an alternating current. I shall afterwards have to point out the practical importance of this fact. On the table before me are many different kinds of electro-dynamometers, which have been lent to me by Messrs. Siemens Brothers, and you will be able to examine them afterwards; in each case you

will see that there is a fixed coil or coils of wire which can be traversed by the current to be measured, and a suspended coil which is also traversed by the same current which passes through the fixed coil. The suspended coil is hung up by a steel spring which resists the movement of the movable coil. When the current passes through the instrument, the movable coil is twisted round, and the amount of torsion which has to be applied to it to bring it back to its original position is the measure of the mean square value of current strength.

Before going on to discuss in detail various classes of practical instruments which depend upon the principles just explained, it may be convenient to give here a brief classification of electric measuring instruments. The Table below will show that these instruments may be classified into six divisions, depending on the kind of quantity they are intended to measure. They may also be classified into five species, depending on the particular physical principle which is employed in the instruments. It is not, however, every one of all possible varieties of such instruments that exists. Those instruments which have practically been made are indicated by an asterisk in the Table below:—

	Electro-Dynamic.	Electro-Magnetic.	Electro-Thermal.	Electro-Chemical.	Electro-Static.
Ammeters or Current Meters.	*	*	*		
Voltmeters or Pressure Meters.	*	*	*		*
Ohmmeters or Resistance Meters.		*			
Coulomb Meters or Quantity Meters.				*	
Erg Meters or Energy Meters.	*	*			
Watt Meters or Power Meters.	*	*			*

Taking then the first species of instruments, namely, those depending on electro-dynamic force, I will proceed to describe the valuable instruments invented by Lord Kelvin. Broadly speaking, these instruments may be described as electro-dynamometers, in which there are four fixed coils, around or between which are placed two movable coils attached to a balance arm. Before me on the table are some fine examples of the current balance lent by Messrs. James White and Co. The particular point to notice in these instruments is the manner in which the balance arm which carries the movable coils is suspended, so as to permit the coil to move freely, and will enable us to get the current into and out of the movable coils. Lord Kelvin solved that problem by the highly ingenious arrangement of suspending the balance arm by a large number of very fine copper wires. These flexible ligaments of copper are fixed at one end to a pair of fixed copper trunnions, and the other ends to projecting copper lugs attached to the balance arm. When the balance arm is in equilibrium the movable coils occupy a position between the fixed coils, and the connection of the circuits is such that the current can be passed through the whole of the coils in series. When this current so passes it brings into existence forces of attraction and repulsion between the fixed and movable coils, and the balance arm is tipped over in one direction. Equilibrium can then be restored by moving a sliding weight along a tray attached to the balance arm, and when the balance is obtained the position of this weight can be read by means of a scale. By the principles above explained the force required to hold the beam in its position of equilibrium is proportionally to the square of the current strength, and accordingly the beam can be graduated in such a manner as to read off currents directly.

In accordance with what has been above said, it is necessary, when these balances are used for alternating currents, to avoid bringing any metal piece into contiguity with the coils. Accordingly the base of the balance is made of slate, and the coils wound on either slate or porcelain bobbins, or on some material which is a non-conductor. The balance is calibrated for use by means of a steady current, and it is then available for use with alternating currents. Lord Kelvin has devised a whole series of these instruments, which are capable of measuring currents from one thousandth of an ampère, up to one thousand ampères, and each instrument has a range of about 1 to 100. The latest pattern of centi-ampère and kilo ampère balance is shown in Figs. 5 and 6 (pp. 847 and 848).

A reference has already been made to the electro-dynamometers of Siemens, and before you are a series of these instruments, lent to me by Messrs. Siemens Brothers, and which is illustrated in Fig. 7 (p. 849). In all these dynamometers there is a fixed coil and a movable coil, both of which are traversed by the current to be measured. The current is got into and out of the movable coil by means of mercury cups, and the movable coil is brought back to its normal position when displaced by the current by means of the torsion of a spiral spring.

Another instrument of the electro-dynamometer class, but involving a slightly different principle, is one which I devised many years ago, and which depends on the principle of the repulsion of a copper disc by an alternating current. In this instrument there is a fixed coil of wire, which is traversed by the current to be measured. In the interior of this coil of wire there is a small copper disc, which is suspended by a fine wire. The disc is so placed that in its normal position its plane is inclined at an angle of 45° to the axis of the corner. When an alternating current is sent through the coil, the copper disc turns round so as to place its

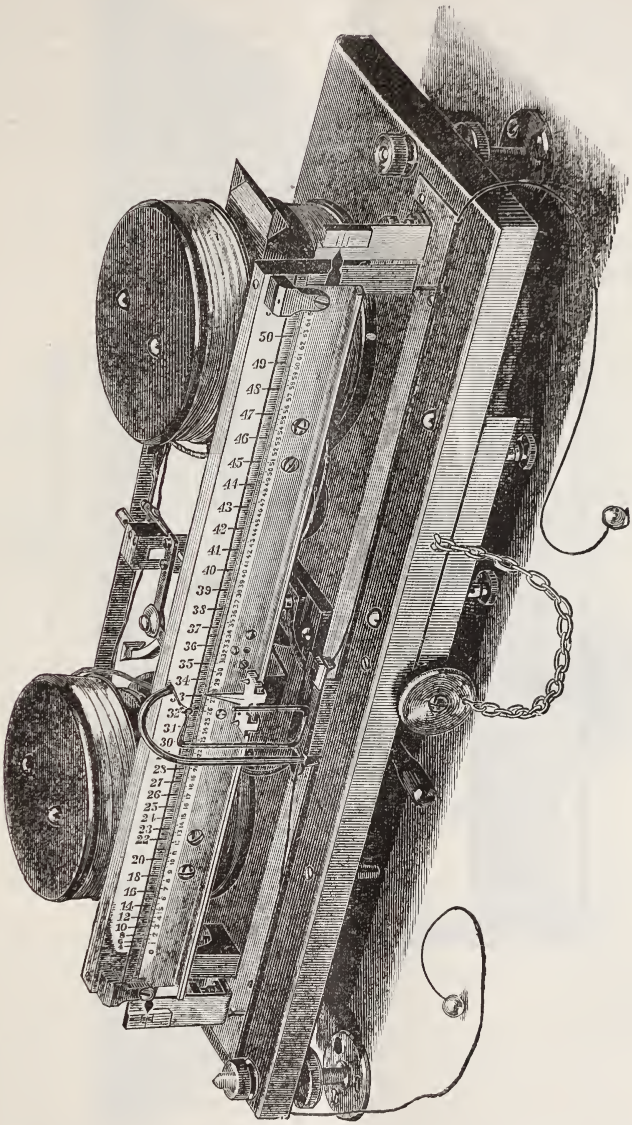

Fig. 5.—Standard Centi-Ampere Balance.

plane in the direction of the axis of the coil. The torsion of the wire resists this movement, and the copper disc takes up some position of equilibrium. An instrument of this kind can be made to measure very small alternating currents such as those of about one thousandth of an ampère. Quite recently I have determined the law of deflection of this instrument, and I find that the angular displacement of the disc from its position of equilibrium is closely proportional to the square of the current strength passing through it. By attaching a mirror to the copper disc, the angular movements can be very much magnified, and the instrument then becomes available for detecting small alternating currents.

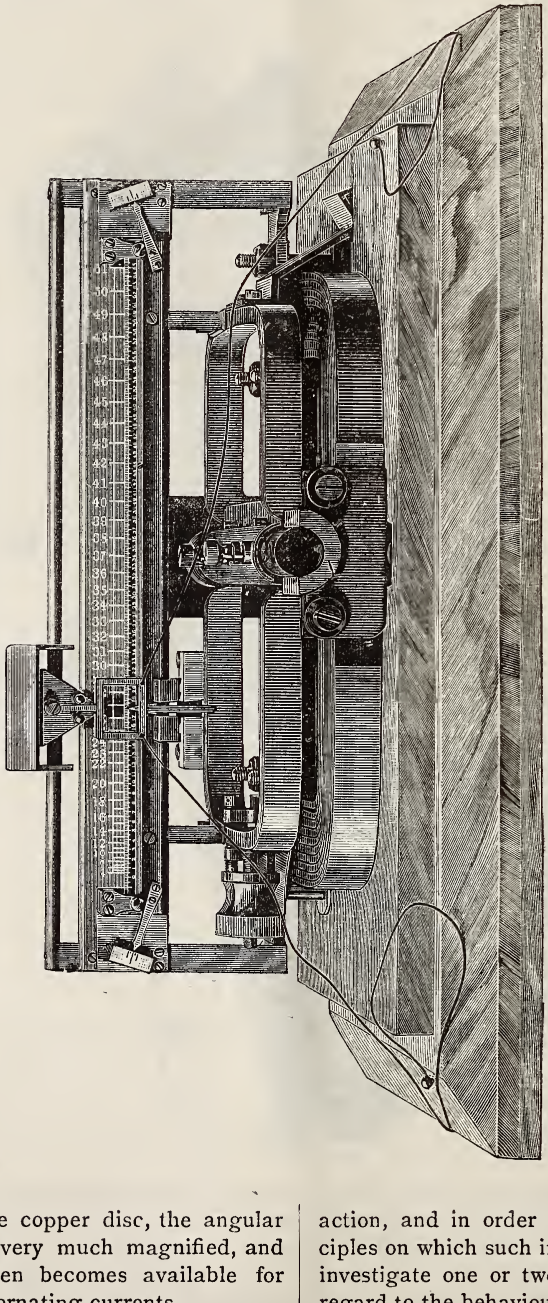

Fig. 6.—Standard Kilo-Ampere Balance.

We must next pass on to consider instruments which depend on electro-magnetic action, and in order to understand the principles on which such instruments act, we must investigate one or two elementary facts with regard to the behaviour of iron in a magnetic field. I have before me a small coil which I will place in a horizontal position in the field

of the optical lantern, and in the centre of that coil I suspend a small fragment of iron. You see on the screen the shadow both of the coil and the iron. On passing an alternating current through the coil, the piece of iron is drawn away from the centre of the bobbin, and moves up against the side. The explanation of this fact is that a piece of soft iron, when placed in a varying magnetic field, tends to move from places of weak to others of stronger magnetic force, and other things being equal, the force so displacing the iron at any point is proportional to the product of the strength of the field, and the rate of change of the field at that point. We may show the experiment in another way. If we place a sheet of glass over the coil, and sprinkle on it some iron filings, and then pass a current through the coil, the iron filings all move outwards from the centre of the bobbin to the edge, the reason for this being that the magnetic field of the bobbin is weaker at the centre than it is close up against the wire. This principle is employed in the construction of a large number of instruments. I have before me a selection of Professor Elihu Thomson's instruments depending on this principle, and which have been lent to me by

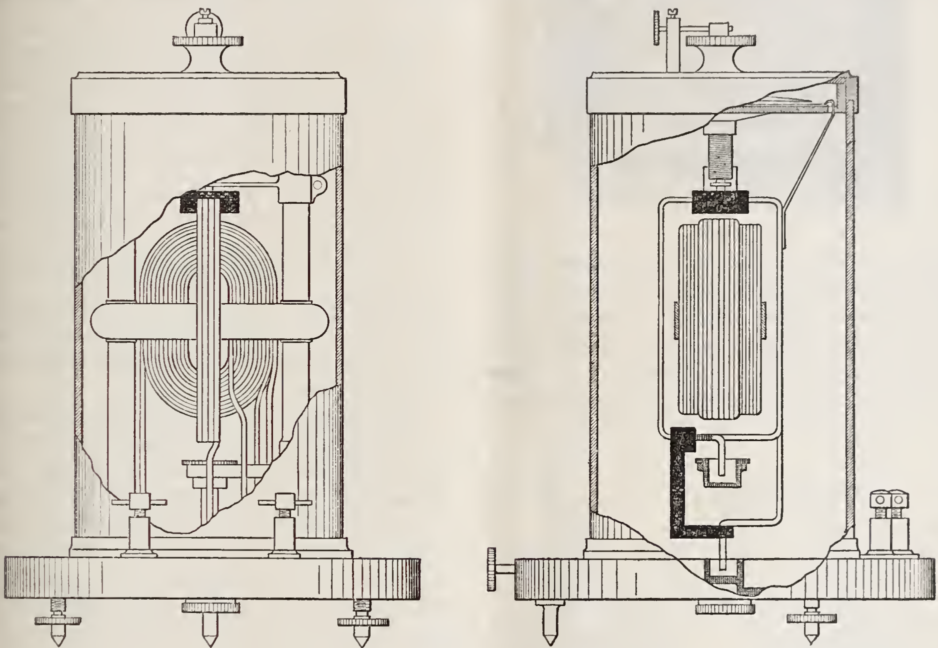

FIG. 7.

Messrs. Laing, Wharton, and Down, which are instruments employed for measuring alternating currents.

In these instruments (Fig. 8, p. 850) a small plate of soft iron is attached to an axis which passes through the centre of a bobbin in such a manner that, if the iron is displaced from the centre to the edge of the bobbin, that movement is indicated by a needle. Hence, when an alternating current is passed through the coil, forces are brought to bear on the iron, tending to displace it from the centre to the edge of the coil. A weight is so arranged as to resist this movement, and the instrument may be calibrated for different current strengths, and constitutes what is called the gravity instrument, because no springs are used in its construction.

Another very similar instrument is that devised by Von Dobrowolsky. In this instrument, which is intended for the measurement of alternating currents, there is a coil of wire (Fig. 9, p. 850), and in this coil of wire is suspended a very slender fragment of iron wire. When an alternating current is passed through the coil, the iron is drawn down into the coil, owing to the tendency it has to move from weak to strong places in the field. This movement of the iron is resisted by the gravity of a small weight. A needle, attached to the axis which carries the fragment of iron wire, moves over a graduated scale, and the instrument can be calibrated as an alternating current ammeter.

Another instrument depending on the same principle is that of Nalder. In this

instrument, which resembles in general construction the ammeter of Elihu Thomson, there is a fixed coil through which the current to be measured passes, and on an axis passing through this bobbin there is fixed a small plate of iron, the field of the binder is made stronger in one part than in others by

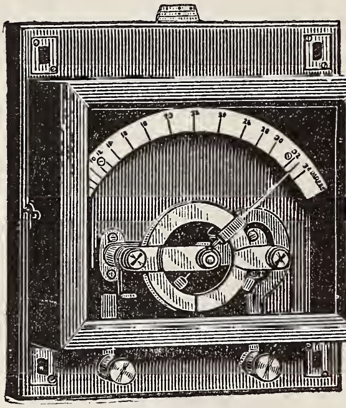

FIG. 8.

placing a fixed plate of iron in the opening of the bobbin. When a current is passed through the coil, the movable plate of iron is drawn towards the fixed plate, and in so doing turns round the axis to which it is attached. A needle fastened to the axis moves over a divided scale.

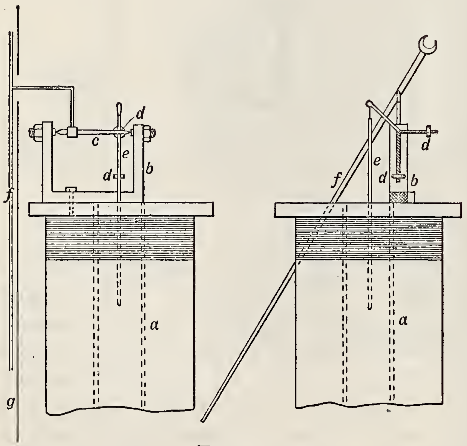

FIG. 9.

A fourth instrument depending on the electro-magnetic principle is that of Mr. Evershed, of which I have examples lent me by Messrs. Goolden and Co. In Evershed's alternating current ammeter there is a fixed coil of wire through which an axis passes. This axis carries a small piece of soft iron like a hammer, which is fixed to the axis. Within the coil there are two soft iron cheeks, and between these is formed a strong magnetic field when a current passes through the coils. On passing the current, the movable piece of iron is drawn down between the two fixed cheeks, and this movement is resisted by a weight carried on the axis. The piece of soft iron therefore takes a definite position under any given current which depends on the relative forces acting upon the piece of soft iron. In these electro-magnetic instruments it is important to know that in employing them for alternating currents the majority of them have to be calibrated for the particular frequency at which they are to be used. We must not take it for granted in using an instrument of this class that its readings will be identical for alternating currents of different frequencies. In the Evershed ammeter, however, a compensation is provided to meet this difficulty, and to make the instruments give identical indications, although the frequency of the alternating current may be varied. The working coil is shunted by an inductive shunt, this shunt takes about 6 per cent. of the total current as direct currents, but only about 2 per cent. as alternate currents. The result is that the working coil takes about 2 or 3 per cent. more current with alternate currents, and eliminates any error due to eddy currents set up in the bobbin frame and case.

Before leaving the subject of electro-magnetic instruments for the measurement of alternating currents, I may point out one instrument before me which can be employed for the measurement of such small currents as those produced by a telephone. In this instrument there is a fixed coil of wire, and in the centre of this coil is suspended a very small fragment of soft iron wire, with its axis inclined at an angle of 45° to the plane of the coil. The wire is hung up by a cocoon fibre, and, by means of a little fragment of mirror attached to the iron, we can detect the smallest movement of the iron. On connecting a telephone to the coil and singing or speaking to it, you see that the iron needle is deflected. The alternating current produced by the telephone passing through the coils of the instrument creates a magnetic field in the interior, and the fragment of soft iron wire tends to turn round so as to place its greatest lengths in the direction of the field of the corner. Hence the presence of a small alternating current can be detected. By making suitable arrangements and suspending the fragment of wire by a quartz fibre, it is possible to make an instrument sufficiently sensitive to measure the millionth part of an ampère.

I now pass on to consider those instruments for the measurement of alternating currents of strength which depend upon the thermal principle, that is to say, depend for their action upon the heating of a conductor through which the current passes. The first of these, which I will describe, is the one which is called the twisted strip ammeter, of Professors Ayrton and Perry. In this instrument a strip of platinoid is stretched between two supports and twisted round in the middle, so that the two halves of the strip form right and left-handed spirals. When this is done, and the strip fixed at its two extremities, if an electric current is passed through it, and heats it, the strip tends to twist up more. If an index needle is attached to the centre of the strip, then the passage of a current through the strip may be made to cause this needle to move over a scale, and the position of the needle at any extent to indicate the current going through the strip. If the strip is enclosed in a tube made one-third of iron and two-thirds of brass, the ends of the strip being attached to the ends of the tube by an insulating support, then no raising or lowering of the temperature of the strip and tube, as a whole, will affect the length of the strip, and hence such an arrangement will constitute a compensation for external temperature. If, however, the strip be supposed to be cooled or heated apart from the tube, it will untwist or twist up more. In order to be able to observe the movements of the strip relatively to the tube, a slit is to be cut in the side of the tube through which the needle attached to the strip can project. In the real instrument the tube containing the strip is fixed on to a stout bracket which divides it into two parts, the compound tube having the same co-efficient of expansion as platinoid. A needle attached to the centre of the strip projects through a cut in the tube, and moves over a divided scale. If a current is passed through the strip it heats it, and after a short time the strip assumes a certain definite temperature which is attained when there is a balance between the rate at which the heat is generated in the strip, and the rate at which it is radiated to the walls of the enclosing tube. Accordingly there is a definite position of the needle corresponding to any particular mean square value of the strength of the current, and by passing steady currents through the instrument it can be calibrated for use with alternating currents. Such an ampère meter can be made to read from about ·2 to 5 ampères, reading by hundredths of an ampère. For the ready measurement of small currents the instrument is convenient, but there are certain difficulties connected with its use which are common to all such thermal instruments.

We may next take note of a very ingenious hot strip ammeter, invented by Captain Holden, several examples of which, lent by Messrs. Pitkin and Co., are before me. In this instrument there are two metal strips, and (see Fig. 10), of the same length, section, and material.

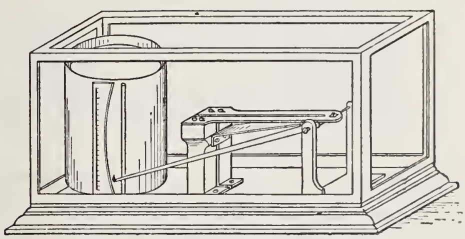

FIG. 10.

These strips are fastened together by rivets, or otherwise secured at the point, E (see Fig. 11), and they are also fastened at the other ends to the framework of the instrument. These strips of metal are each of them of a horse-shoe shape, and, from proper terminals, a current can be passed through one of these strips. If this is the case, the strip becomes heated, and, if one strip is heated, say the top one, whilst the other one remains practically of the same length, the compound strip will be obliged to assume a new position, as indicate

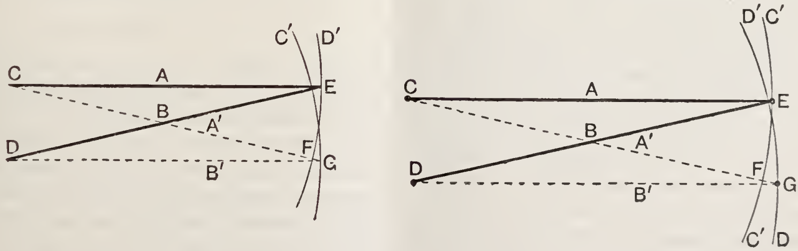

FIG. 11.

by the dotted lines in Fig. 11. This distortion of the compound strip is made to affect a system of levers which multiplies the motion, and an index arm may thereby be caused to move over a scale, or to move a writing pen over a revolving cylinder. It will be seen that a general rise of temperature of both strips simultaneously, such as would be produced by taking the instrument into a warm place, will not affect the form of the compound strip, since each strip lengthens equally, and therefore there will be no turning movement.

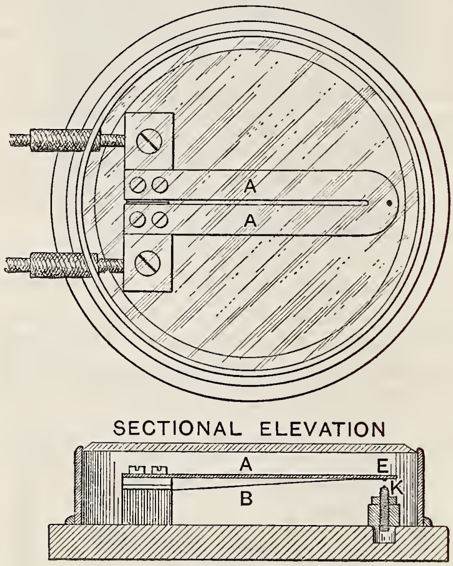

Fig. 12.

In Fig. 12 we have a plan showing the horse-shoe shaped strip, the ends of which are attached to insulated blocks of metal, which form the terminals of the instrument. The controlling strip, which is fastened underneath, and is indicated by the letter B, is a plain strip, rivetted at one end to A, and the other end to an insulated piece carried on the terminal blocks. Such an arrangement of compound strips may be employed, not only as an alternating current ammeter, but as a means for closing the circuit when a current is increased above a certain amount. A recording ammeter, made on this principle, which is an exceedingly simple and effective instrument for recording the strength of large alternating currents, and the rigidity of the strip causes the ammeter to be remarkably dead-beat. In the next lecture I shall proceed to describe how these principles are employed in the construction of instruments for the measurement of alternating current pressure.

Miscellaneous.

SOUTH KENSINGTON MUSEUM.

The famous carpet from the Mosque at Ardebil has now been secured for the South Kensington Museum and is exhibited in the Indian Section. It measures 34 feet 6 inches in length, and 17 feet 6 inches in breadth. The fineness of its texture may be gathered from the fact that there are 300 (hand-tied) knots to the square inch, which gives 33,000,000 knots in the whole carpet. The design consists of a large central medallion in pale yellow, surrounded by cartouches of various colours, symmetrically disposed of on a dark blue ground covered with floral tracery. Each of the corners is filled with a section of a large medallion, similar to the one in the centre, surrounded by cartouches. The large border is composed of long and circular panels, alternating, with lobed outline on a brown ground covered with floral work. At the top of the carpet is a panel, which bears the following inscription :—

> " I have no refuge in the world other than thy threshold,
> My head has no protection other than this porchway,
> The work of the slave of the Holy place,
> " Maksoud of Kashan,
> in the year 942 " (A.D. 1535).

This wonderful carpet and remarkable work of art, owing to its enormous size, fineness of texture, beauty of colour, and splendour of design, is of special interest in connection with the history of Persian carpets, as the inscription affords a clue for fixing the date and the locality of the manufacture of examples of a similar kind. The price of the carpet was larger than the authorities of the Museum were in a position to give, and the sum at their disposal was supplemented by Mr. A. W. Franks, Mr. Steinkopff, Mr. William Morris, Mr. J. E. Taylor, and other gentlemen.

General Notes.

The Chinese Trade in Aniline Colours.—The *Journal des Mines* announces that the importation of aniline colours into China is increasing every year. The colour most in demand is scarlet, which is used for dyeing paper and cotton. Yellow, the imperial colour, is only employed in the Government workshops. For this article great attention should be paid to the labels and description under which it is introduced and brought under the notice of Chinese purchasers. Shanghai is still the centre for the importation of colours. The trade is in the hands of German houses, although all the products introduced are not of German origin; they also come from England, Belgium, and France.

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Proceedings of the Society.

CANTOR LECTURES.

THE PRACTICAL MEASUREMENT OF ALTERNATING ELECTRIC CURRENTS.

By Prof. J. A. Fleming, M.A., D.Sc., F.R.S.

Lecture II.—Delivered February 6, 1893.

The Measurement of Alternating Current Pressure.

Before proceeding to discuss the various types of practical instruments for measuring alternating current pressure, it is necessary to pay attention for one moment to a distinction between electric circuits. I shall have to employ frequently the phrases inductive and non-inductive circuits, and I wish you to be perfectly clear as to the exact meaning of these terms.

Every electric conductor has the property of producing a dissipation of energy when an electric current is passed through it, and it has also the property, as a natural consequence of the above fact, of producing a fall in pressure in the current falling through it. If we consider for one moment a continuous current flowing through a conductor, then if by suitable means we measure the potential at both ends of this conductor, we find there is a fall in potential, or, as it is called, a drop in pressure down the conductor. The number by which we must multiply the strength of the current in ampères to obtain the fall in pressure measured in volts is the numerical measure of the resistance of that conductor measured in ohms. The rate at which energy is being dissipated in that conductor is numerically measured in watts by the product of this resistance, and the square of the strength of the current. So far, all is simple when we are dealing with unvarying currents. If, however, we are using alternating currents then we should not find that the product of the resistance of the circuit and the $\sqrt{\text{mean-square}}$ value of the current gave us always the $\sqrt{\text{mean-square}}$ value of the drop in volts, neither would it be always true that the product of the resistance of the circuit and the mean-square value of the current would give us the mean value of the power taken up in that circuit. In other words the drop in volts which would actually be observed in the case of an alternating current circuit, especially if it is a circuit wrapped round iron, is more than can be accounted for by the simple resistance of the wire. We find we have in this case to take into account another quality of the circuit, which is called its self-induction. In the case of such a circuit the number by which we have to multiply the $\sqrt{\text{mean-square}}$ value of the current to obtain the $\sqrt{\text{mean-square}}$ value of the electromotive force is the measure of what is called the impedance of that circuit. We can always measure the resistance of a circuit by means of a Wheatstone's bridge, and if taking any circuit we find that when an alternating current is passed through it the ratio of the $\sqrt{\text{mean-square}}$ value of the drop in volts down that circuit, to the $\sqrt{\text{mean-square}}$ value of the alternating current flowing in that circuit is greater than the true resistance of that circuit, such a circuit is called an inductive circuit, and the above ratio is a numerical measure of its impedance. I can best illustrate this by an example. Two wires, one of platinoid and the other of manganese-steel, were wound into spirals round a wooden frame. Each of these wires was about 25 feet long, and made 40 turns round the frame. In the first place a continuous current was passed through each wire, and the fall in volts down each wire carefully measured, the magnitude of the current in both wires being ·802 of an ampère. The drop in volts down the platinoid coil was 67·9, and down the manganese coil 79·7 volts. Accordingly the ratio of volts to currents in the first place is 84.66, and in the second case 99·38. This being done, an alternating current of the same $\sqrt{\text{mean-square}}$ value, as measured by a Kelvin balance, was passed through the two coils. The fall in volts down the platinoid coil was found to be 68·5, and down the manganese steel coil 80·7. These were the mean-square values. The ratio of volts to current in the first case is therefore 85·41, and in the second case 100. These, therefore, are the impedances of these coils, and it is seen that in each case the

impedance exceeds the resistance. The frequency of this alternating current was 108, and therefore these coils form slightly inductive circuits. I shall point out presently the manner in which practically non-inductive circuits may be obtained; but meanwhile it is sufficient to remark that if an iron core had been inserted in either of these coils, it would have greatly increased the impedance of that coil. It is always possible, however, to ascertain whether the impedance of a circuit differs from its resistance in numerical value. If it does not to any sensible extent, then the circuit is called a non-inductive circuit. If the impedance is greater than the resistance, then the circuit is called an inductive circuit. There are many cases in which inductive circuits cannot be employed, but in which we must secure, by some means or other, a practically non-inductive circuit. Such a non-inductive circuit can be formed of a series of incandescent lamps, and for larger currents it can most conveniently be obtained by using rods formed of a mixture of plumbago and fire-clay, mixed in proper proportions to secure the necessary resistance, and then baked.

Turning now to the question of the measurement of alternating current pressure, we will consider the various types of instruments which can be used for this purpose. In the first place, any one of the class of electrodynamometer instruments or electro-magnetic instruments described in my last lecture, which can be wound with very fine wire, so as to make a current-measuring instrument of high resistance, can thereby become an instrument for the comparison of alternating current pressure, provided that certain precautions are employed.

In the first place, we may make a high-resistance dynamometer by winding a dynamometer with a wire of high specific resistance and of necessary length. The impedance of this instrument is, therefore, a fixed quantity, provided that we are dealing always with alternate currents of the same frequency. The indications of the instrument are indicative of $\sqrt{\text{mean-square}}$ value of the current flowing through it; and hence, by what has been above said, as to the definition of impedance, it follows that the $\sqrt{\text{mean-square}}$ value of the alternating current-pressure at the terminals of the instrument will also be given by the instrumental reading.

In other words, we can take such a high-resistance dynamometer, and can graduate it for alternating pressure to any given frequency; but if the dynamometer has an impedance which differs sensibly from its true resistance, then, if calibrated for alternating currents of one frequency, it will not, in general, be identical in its indications for alternating currents of different frequency.

We can, however, nearly always secure the condition that the impedance of such an instrument shall differ by very little from its true resistance, and then, when once it has been calibrated, by testing it with known unvarying pressures, it will enable us to measure alternating current pressures, giving us their $\sqrt{\text{mean-square}}$ values.

In order to obtain the necessary non-inductive quality in such an instrument it is generally necessary to place the greater part of the resistance of the instrument in the form of a non-inductive coil of platinoid wire, which is placed outside the instrument, and then to a considerable extent we may be sacrificing sensibility. The same statements are true with regard to the employment of the electro-magnetic principle in the construction of alternating current voltmeters. In all the instruments described in my former lecture, Siemens dynamometers, the alternating current ammeters made by Nalder, Evershed, Elihu Thomson, and Dobrowolsky, can be

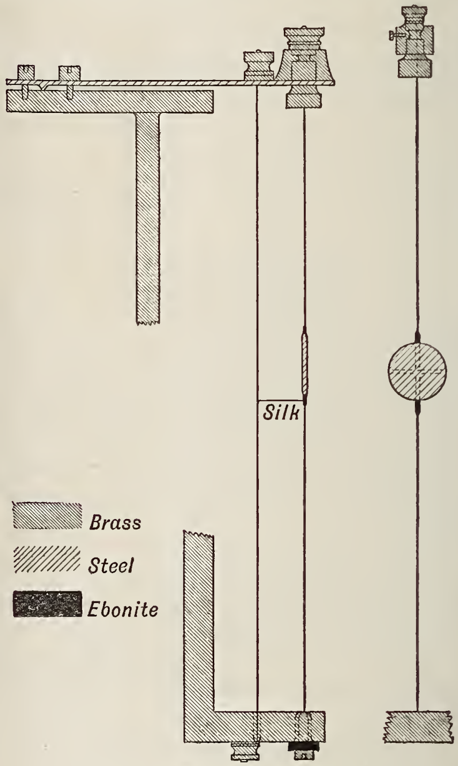

FIG. 1.—HOLDEN VOLTMETER.

converted into alternating current voltmeters by winding them with very high resistance wires, putting that resistance in the form of a non-inductive resistance associated with the measuring part. In Evershed's current volt ammeter there is a compensation for frequency which is worth noting. The voltmeter coil has placed in series with it a coil, the terminals of which are shunted by a condenser. This shunted condenser has the property of neutralising the self-induction of the voltmeter coil, and if properly adjusted, the instrument may be made to give identical scale indications for alternating pressures of widely different frequencies, and be practically compensated for frequency

Turning, then, to the instruments for the measurement of alternating electromotive forces in which the thermal principle is employed, we have, first, the well-known Cardew voltmeter as a typical instrument for the measurement of such alternating pressures. In this instrument a platinum silver wire, of about 300 ohms resistance, is stretched in a tube, and, for the sake of compactness, the wire is folded backwards and forwards four

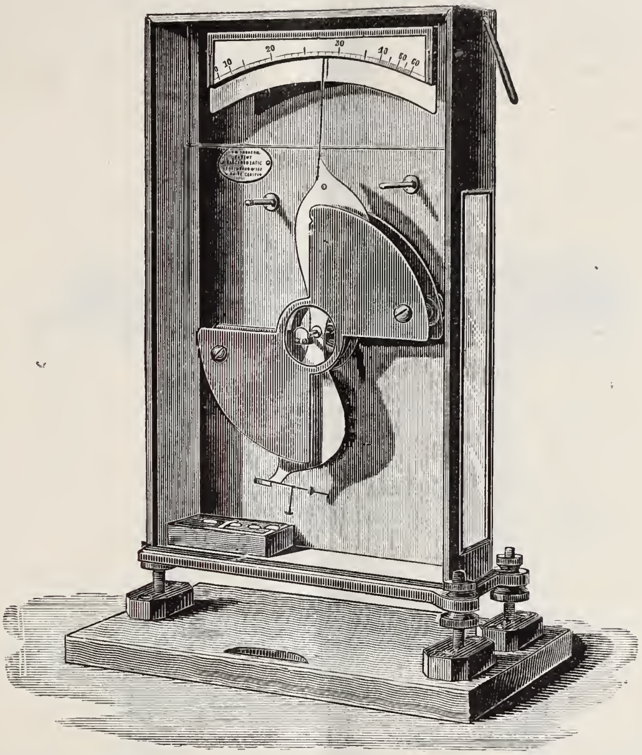

FIG. 2.—LORD KELVIN'S VERTICAL ELECTROSTATIC VOLTMETER.

times over small ivory pulleys. One end of this wire is fixed, and when a current is sent through the wire it becomes heated, and it attains a final temperature if the current passing through it is constant. The wire, therefore, elongates, and the expansion of the wire is measured and detected by a multiplying gear of the following kind. The elongation of the wire is made to cause a revolution of a mechanism consisting of an intergear of wheels and pinions, and to the last axis of the series an indicating needle is attached, moving over a divided dial. The wire has to be held in a tube or frame, and there are two types of this instrument, called respectively the rod and the tube type. In the rod type of instrument, which is the easiest to manufacture, the platinum-silver wire is kept extended by being fastened to two rods, formed one-third of iron and two-thirds of brass. The whole instrument is then enclosed in a brass case. When the current is passed through the wire it heats it, and the rods become heated also by radiation from the wire. It takes a certain time before the rods settle down into a final state of temperature, in

which the heat received by them is equal to the heat radiated by them. Until this is the case, the instrument does not come to its final reading. In the other type of instrument, called the tube instrument, the wire is attached simply to the brass and iron tube, which forms the case of the instrument. In this latter type the outside tube arrives very much more quickly at its final state of temperature, and hence the instruments of the tube type are preferable for accurate work on account of the fact that they thus come much more quickly to their final readings when put upon the circuits. The Edison-Swan Company manufacture a type of Cardew voltmeter which is easier to string than the ordinary tube instrument, and yet has all the advantages of that instrument.

Another disadvantage which the rod instrument possesses is that there is generally a considerable negative variation of the needle, on taking off the current. The rods do not cool as quickly as the wire, and therefore when the current is taken off, the needle goes back beyond the zero of the scale. The instruments are generally made for reading pressures from 40 to 150 volts. In the manufacture of the instruments the wire has first to be carefully

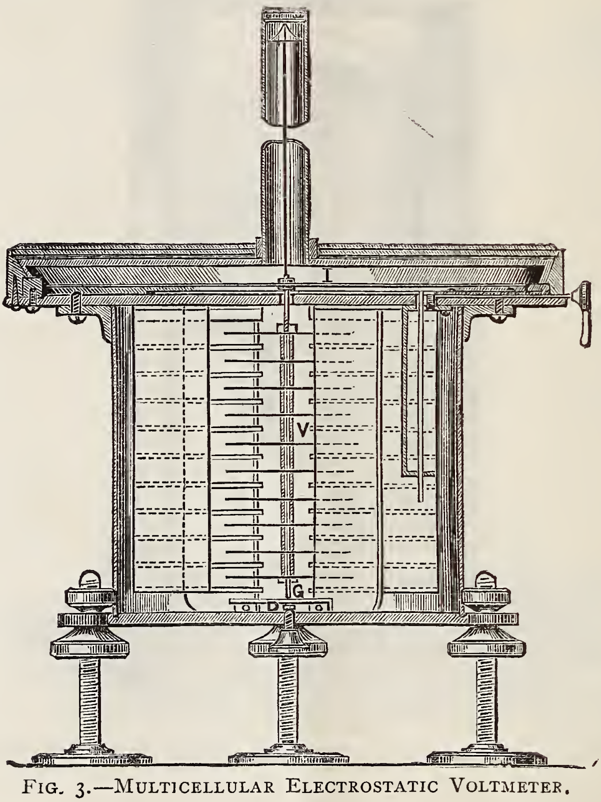

FIG. 3.—MULTICELLULAR ELECTROSTATIC VOLTMETER.

aged by putting current on and off for some time at intervals of one minute, so as to heat and cool the wire. In this way a certain variation in expansion is got rid of, and the platinum-silver wire is brought into a condition in which it always is the same length and the same temperature. These Cardew voltmeters are really of course alternating current ammeters which take a current of about one-third of an ampère at 100 volts. The instrument of this range therefore dissipates a power of 30 watts, and, as I shall point out later on, has the disadvantage of wasting a considerable amount of energy if kept continuously upon the circuit, but when carefully made the Cardew voltmeter is an instrument of great value for measuring alternating current pressure. A special form of this Cardew voltmeter is also made by the Edison-Swan Company for engine-room purposes, the dial of which is very large, and which is graduated say from 80 to 110 volts. In this way such a graduation is given to the instrument that a variation of one volt can be

easily seen at a considerable distance. There are some modifications of the Cardew voltmeter which are useful in measuring very small alternating electromotive forces, such as the voltmeter of Captain Holden, which you will see amongst the instruments lent by Mr. Pitkin. In this instrument a short and very fine platinum silver wire is stretched between two supports and it is kept sagged in the middle by means of a small spring (see Fig. 1). To the centre of the wire is attached a thread, also attached at the other end to the side of a small mirror. If the sag of the wire increases or diminishes, the mirror is more or less pulled round. When a current is passed through the wire it heats it. The sag increases and the mirror is moved. If I apply a very small current to the terminals of the instrument before me, given by a single cell of a battery, you see by the movement of the spot of light upon the screen that the instrument is capable of detecting a very small difference of pressure between its terminals, and in fact such an instrument is capable of measuring one hundredth of a volt alternating pressure. This instrument will measure without an external resistance from nothing up to two volts conveniently, and by putting the external resistance in series with it, and by employing a long ray of light the instrument can be made to indicate pressures of any required voltage with great accuracy. Captain Holden has converted the above described instrument into a useful self-registering voltmeter making a photographic

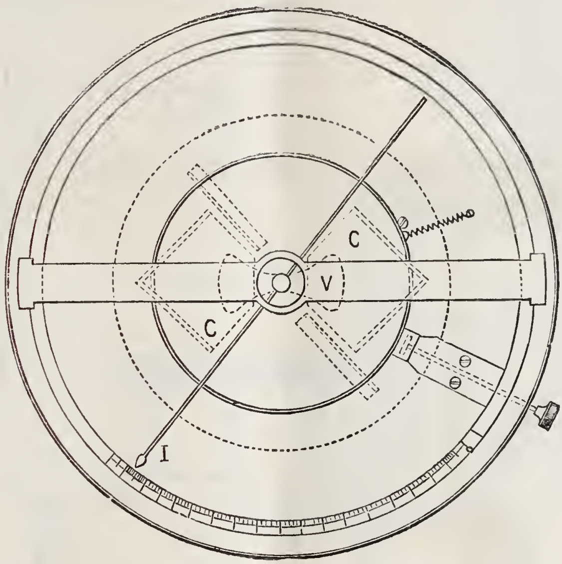

Fig. 4.—Multicellular Electrostatic Voltmeter.

record of variation in pressure. This is achieved by letting the ray of light reflected from the mirror fall upon a revolving drum covered with photographic paper. The drum turns round by clockwork once in 24 hours, and the ray of light marks a photographic record of the revolving paper by which any variation in the pressure is detected and measured. A similar low voltage thermal voltmeter is constructed for use with secondary batteries for measuring the electromotive force of each cell. In using such thermal voltmeters it is necessary to avoid convection currents of air in the enclosing tube or case. In using a Cardew voltmeter it is generally found best to place the instrument with the tube horizontal. In this way the variable cooling effects of the air currents in the tube are, to some extent, prevented. If a Cardew voltmeter is used with its tube vertical, the needle will be observed to make small movements to and fro, even if the current is perfectly steady. These movements of the needle may, if they occur, prevent the pressure from being accurately read within less than one volt.

We must now pass on to notice instruments for the measurement of alternating pressure which depend upon electro-static attractions. These electro-static instruments have for many purposes very great advantages, the most notable of which is that they do not consume power, and that therefore they may be left to

the circuits indefinitely without cost. The first of these instruments which I will describe is Lord Kelvin's electro-static voltmeter for high pressures. In Fig. 2, p. 857 is shown a sketch of this instrument. You will notice that it consists of four quadrant shaped plates which are connected to one terminal of the instrument. Suspended between these plates, but insulated from them is a paddle-shaped aluminium needle, which swings on very delicate pivots. The needle is connected to the other terminal of the instrument. The instrument, in fact, forms a condenser, of which one plate is fixed and the other is movable. When a difference of potential, varying from 1,000 to 5,000 volts, is produced between the terminals of the instrument, the movable plate is attracted in between the fixed plates. This movement is resisted by weights, which are hung on the bottom of the needle.

When two plates, in fixed positions, have produced between them a difference of potential, the force required to hold them in any given position is proportional to the square of the difference of potential between them. To the end of the aluminium needle is attached a long pointer, moving over a divided scale, and the instrument is gradiated in such a manner as to read directly in volts. Since the attraction between the plates depends upon the square of the potential difference, it is independent of sign, and therefore the instrument works equally well with direct or alternating pressures; and, in this latter case, it gives us the $\sqrt{\text{mean-square}}$ value of the potential difference between the terminals of the instrument.

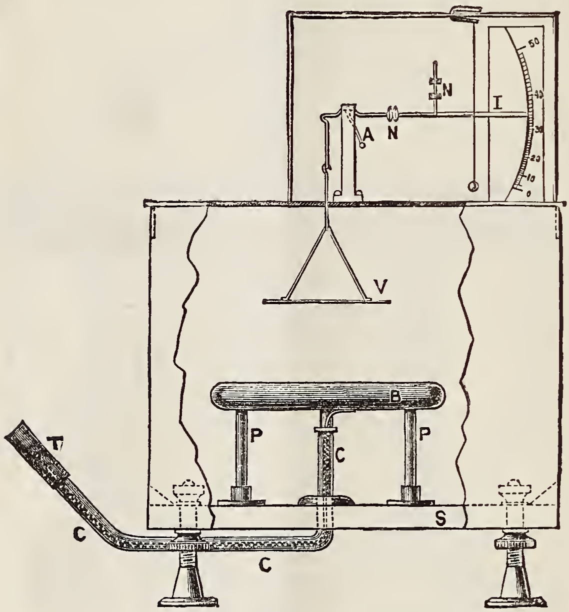

Fig. 5.—Electrostatic Balance.

Another instrument, also invented by Lord Kelvin, but adapted for measuring lower pressures, is the multicellular electro-static voltmeter. In this instrument there are a series of quadrant-shaped plates (see Figs. 3 and 4, pp. 856, 857), placed one above the other, which are called cells. There are then a series of paddle-shaped needles, all attached to a common axis, which is hung up by a platinum silver wire. The normal position of the needles is just outside the quadrants, but if a difference of potential is created between the needles and the cells, and the needle is drawn or attracted into the cells. This movement is resisted by the torsion of the suspending wire. An indicating needle, attached to the axis, moves over a divided scale; and the instrument, which can be arranged to measure from 40 volts upwards, gives us, therefore, the $\sqrt{\text{mean-square}}$ value of the potential difference between the cells and the needle.

In these instruments there may be a very small error in reading, which is dependent upon the existence of a small electromotive force of contact between different metals. If

the cells are made of brass and the needle of aluminium there is a small contact difference of potential which is due to these different metals, and which may amount to something less than half a volt. Accordingly it will be found that in such an instrument reading say 100 volts, the reading given by the instrument will depend upon whether the cells are positive or negative, and a small correction has to be applied depending on the manner in which the instrument has been joined up in calibrating it. Similar instruments for measuring potential differences of much larger amount have been invented by Lord Kelvin. In Fig. 5, p. 858, is shown the internal arrangements of an instrument intended for measuring from 5 to 40,000 volts. In this instrument the electro-static attractions between two plates are balanced by the gravity of a weight. One of the plates is a fixed insulated plate, and the other a movable plate hung on a balance arm. The movement of a needle over a scale indicates the pressure in volts. Instruments similar in principle to the above have been devised both by Professor Ayrton and Mr. Swinburne. In both these instruments the same principle is employed. There is a fixed insulated plate and a movable plate to which is attached a needle. The electro-static attractions between these plates are made to move the needle over a divided scale. Lord Kelvin has also devised a form of multicellular voltmeter which is useful for Central Station purposes as it has a vertical scale, and the instrument (see Figure 6) is intended to be attached to a switch-board. I may now point out the advantage of these electro-static instruments to which I referred a moment ago. Take for instance a thermal voltmeter absorbing 30 watts, and assume that this instrument is kept connected to the circuits in the dynamo room of a central station all the year round. Since there are, roughly, 8,000 hours in a year, this instrument, absorbing 30 watts, would in one year dissipate 240 Board of Trade units of electric energy. If we reckon this energy as costing 1d. per unit, it is evident that this instrument will cost 240d., or £1 per annum, to keep it going. In reading alternate current pressures higher than 100 volts, a transformer has to be interposed between the circuits and the voltmeter, to reduce the pressure. This transformer will also use up energy, and if it takes no more than the voltmeter it will also waste £1's worth of electric energy in the course of a year. We see, therefore, that an electrostatic instrument which wastes no energy at all is, in cost of up-keep, much superior to the electro-thermal or the electro-magnetic type of instrument, and in fact we can afford to spend a great deal more on an electro-static instrument, and yet effect a total saving in the cost of the electric measurements in that station. For suppose we capitalise our £1 at 10 per cent., we can then afford to spend £10 more on an instrument of the electro-static type than one of the electro-thermal or the electro-magnetic type, which wastes no more than 30 watts if we keep them on the circuits always. There is, therefore, every reason to believe that in course of time electro-static instruments for the measurement of pressure will entirely supersede instruments of the electro-thermal or electro-magnetic type, in all those cases in which the instruments have to be kept upon the circuits constantly. We may employ these electro-static voltmeters for the measurement of alternating currents, and convert them into alternating current ammeters in the following way. Let a non-inductive resistance, say of platinoid wire be constructed which is capaple of passing without sensibly heating the current to be measured, and let

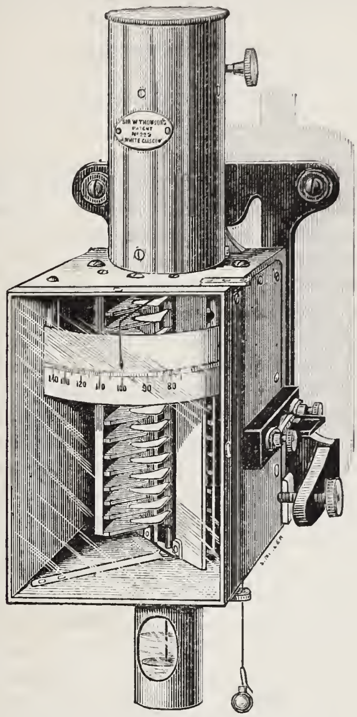

FIG. 6.—ELECTROSTATIC VOLTMETER FOR LOW-TENSION CIRCUITS.

the resistance of this wire be accurately known. Then to the ends of this circuit attach an electro-static voltmeter. Knowing the difference of pressure between the ends of the resistance and its resistance, we know the current flowing through it. In many cases, as in measuring the primary currents of a transformer at no load, it is much more convenient to employ such an electro-static voltmeter and non-inductive resistance than any other method. Suitable non-inductive resistance can always be made by coils of platinoid wire, joined in parallel; and these must be so adjusted that the final temperature they attain is not more than a few degrees above the normal temperature.

Miscellaneous.

THE SILK INDUSTRY IN RUSSIA.

For some years past Russia has been a producer of silk, and its annual production is used for home consumption, while sufficient is left of the waste silk to allow of a considerable export trade being carried on in this article; and the same may be said of raw silk. According to the *Moniteur des Soies*, the export of cocoons, in 1891, amounted to 80 tons, of waste silk to 230 tons, and of raw silk to 26 tons, representing, in the aggregate, an approximate value of more than £80,000. This, it may be said, is not a very large amount; but, it must be borne in mind, that Russia is only in its infancy as regards its manufacturing industries, and that, in order to encourage the new silk factories, her customs' duties have gradually been increased to £14 7s. 7d. per cwt. for silk undyed yarns imported into the country; to £22 12s. 11d. per cwt., for dyed yarns; and, dating from the 1st July last, these duties have been still further increased by 32 per cent. As regards silk stuffs, such as foulards, ribbons, velvets, plush, &c., these are liable to a duty of £148 15s. 10d. per cwt., and stuffs of half silk pay a duty of £59 11s. 2d. per cwt. In the production of the raw material, the Caucasus has always taken a prominent position, being subject, however, as regards silk (as well as other articles), to the influence of Persia, as much in the matter of the description of silkworms as to the manner of rearing them, of treating the cocoons, and of reeling the silk. At the time that the silkworm disease was raging, in 1864, the Caucasus was producing annually about 800 tons of raw silk, valued at about 10 millions of roubles. Official statistics show that during the last twenty years the production has averaged 6,000 tons of cocoons annually, yielding 325 tons of raw silk. In this district the washing of the cocoons is generally done in simple hand basins, but still there are considerable numbers of small spinning factories using machinery. A factory working with a 10 horse-power engine and two steam boilers can reel annually 32 tons of cocoons, producing 5 tons of raw silk, worth, in the Moscow market, about 1,000 roubles per cwt. For this work, about 170 persons would be employed, and their wages would vary between 5d. and 1s. 8d. a day, according to their skill. The kilogramme (2,204 lbs. avoirdupois) of silk reeled in the Asiatic manner fetches, in the home market, from 7 to 15 roubles, while that reeled in the European manner realises from 12 to 21 roubles. The yield of silkworms' eggs varies very considerably according to their origin, and the district of the Caucasus where the breeding is carried on. For example, in the district of Yakataski a Russian pound (equivalent to ·902 lbs. avoirdupois) of Japanese eggs produces 102 lbs. of cocoons, while the same quantity of Italian eggs yields 295 lbs. of cocoons. At the present moment public attention appears to be particularly directed to the question of the silk industry on the part of the Russian farmers and agriculturists, and in several districts special schools of sericulture have been established. These schools have already obtained results, which show how much still remains to be done in this branch of national industry, since, in place of the small yields quoted above, they have succeeded in producing a greatly increased quantity of cocoons. Almost the whole of the Caucasian product is forwarded to the Moscow market, which is the great commercial centre of the production and manufacture of silk in Russia. Some factories are established in Russian Poland, at Lodz and Bielostok, but it is Moscow that, for some years past, has turned out the magnificent stuffs for upholstering, tissues for dresses, ribbons, foulards, &c., which rival the best Lyons products. The silk factories established in Russia consume the raw material in quantities vastly exceeding the actual production of the country. These factories are at the present time, and will continue to be so for some years to come, dependent upon France and Italy for the raw silk, cocoons, and wadding. In 1891, the total imports of these articles into Russia amounted to 250 tons, valued at 2,646,000 roubles. Twisted silk, sewing silk, and waste yarns were imported during the same year to the extent of 402 tons, valued at 6,345,000 roubles.

AGRICULTURAL ASSOCIATIONS IN FRANCE.

Her Majesty's Secretary of Embassy at Paris says that the system of associations, or syndicates for the mutual protection of agricultural interests in France, has made great strides of late years; and associations of agriculturists and others exist at the present day in almost every part of the country, the good effects of which are already beginning to be felt very generally by all the agricultural classes, and proportionally by those employed in *la petite culture*, that is, the

cultivation of farms not exceeding 20 acres. The general object of these associations is shown in the statutes of the *Syndicat General des Agriculteurs de France*, whose aim is stated to be the study and protection of economical agricultural interests, and especially (1) to facilitate the creation of syndicates; (2) to establish an office at Paris for the purpose of supplying information, acting as an intermediary agent, and centralising demands for machines, manures, seeds, and all original substances useful for agriculture, so that subscribers may be able to procure the articles they require retail, but at wholesale prices; (3) to make sure that the goods supplied are genuine; and (4) to make known the best methods of agriculture, and to spread abroad the most reliable professional views and the best economical doctrines. It is further explained in the statutes that one of the objects of the office to be established at Paris will be to assist the sale of agricultural products. Upon the payment of an annual subscription, to be fixed at 20 francs for a founder, 6 francs for a subscriber, and 4 francs for an ordinary member, anyone belonging to the following three classes can become a member of the central syndicate:—Landowners, whether they farm their lands themselves or let it on lease; (2) farmers, husbandmen, agents, or managers, nurserymen, or vine growers, market gardeners and labourers employed in agriculture; and (3) any person in a profession connected with agriculture, or assisting in the cultivation of agricultural products. There are numerous other central syndicates, whose special object it is to assist the work of the local associations, which have been formed for the purpose of protecting various branches of agriculture, but the general principles may be taken to be as stated above. The central syndicate has established at La Villette a special service for the reception and sale of fat stock destined for the Paris market, and a bi-weekly sale has been organised. This service has existed for three years with very satisfactory results, and a tariff of expenses has been fixed for each animal brought to the sale yard in accordance with its species. In the department of the Aisne, a society called the "Société Laitière de Leschelle" was created in 1887, which is conducted on the Danish model, and whose object it is to enable the producers to furnish a first-class commodity direct to the Paris markets, without having recourse to the wholesale dealers, whose intervention naturally reduced the producer's share of the profits. This society already receives the milk of 500 cows, and it is expected that this number will be further increased. The formation of weekly markets and depôts for the sale of agricultural products is one of the chief objects of all the local syndicates, and in the department of Allier the vine growers have established a market, to which only members of the association can bring their wines, but any purchaser can taste the samples and buy the wine offered for sale direct from the producer. The syndicate assumes no responsibility for the integrity of its members, but the detection of a fraud entails the exclusion of the perpetrator from the society, which further publishes the fact, together with the reasons for the same. In Calvados, in addition to the establishment of schools for the preparation and training of saddle and carriage horses, grooms, coachmen, &c., the agricultural syndicate has procured from the large houses great reductions in their prices in favour of its members upon the production of their card of membership; it has organised special arrangements by which would-be purchasers of horses and cattle are put in direct communication with breeders, and, further, undertakes itself to execute sales and purchases. What, however, chiefly concerns the *petite culture* is the establishment of a system by which butter is delivered direct from the producer to the consumer by parcel post. Each parcel sent by post bears the name of the producer; and in the event of the article supplied being found either to be not genuine or to be of a quality inferior to that agreed upon, the syndicate engages to inquire into all complaints made by the consumer, and thus guarantees the commodity. No commission is taken by the syndicate, and the prices charged for the butter are the same as those quoted at the Halles, and much lower than those asked by dealers. In 1892 the following system was instituted by the Calvados syndicate, which has been generally adopted by the syndicates all over France, by which the consumer and producer are put in direct communication. The producer advertises in the monthly bulletin of the syndicate any product which he may have for sale, together with the price he asks, and in order that the consumer may be able to judge for himself of the value of the commodity offered, the producer undertakes to forward a sample by parcels post. In Basse Bretagne a system has been established similar to that which exists in the department of Calvados, by which butter is delivered by parcels post direct by the producer to the consumer. A permanent exhibition has been instituted at Alias, in the department of Gers, and elsewhere, at which samples of products for sale are exhibited, so that any would-be purchaser can find what he wants, and where to procure it, without the trouble of going to the producer, who, in his turn, is saved the expense and labour of hawking his wares; and in the Pyrénées Orientales the difficulties experienced in the sale of wines has caused a proposal to be made that wine markets should be established so as to enable the producer to find a readier sale for his product. The above points would appear to be those which especially concern the sale of products of *la petite culture*, but in the various syndicates numerous other provisions, such as the insurance of cattle against disease, the destruction of noxious insects, and the protection of vines from frost, are taken in the interests of agriculture. Some of the syndicates take a commission on the sales effected by them. In the hilly parts of Savoy and Franche Comté the small holders sell their milk to *fruitières* or cheese makers, whose existence dates

back from the 16th century. A *fruitière* is an association of milk producers, generally the inhabitants of a hamlet or village, and any person may bring his or her milk to the *fruitière*, under the distinct stipulation that he brings all the milk he has and does not deduct any for other purposes, except his own personal use. There are 1,700 of these *fruitières* in Franche Comté, and similar associations exist in the Charente and in some other parts of France. Mr. Townley, in conclusion, says that this system of associations or syndicates has not been long enough in existence for it to be possible to predict with any certainty whether or no it will ultimately prove beneficial to the small cultivator, but from the large increase which has taken place in their numbers it would appear to be giving satisfaction, and it would seem to promise assistance to all classes of agriculturists in the disposal of their products.

PORTLAND CEMENT MANUFACTURE IN CHINA.

Considerable quantities of Portland cement are manufactured at a place called Tongshan, about 80 miles from Tientsin. Consul Brennan says that the raw materials used at the Tongshan works are mountain limestone, fire clay, marl, and a rough kind of China clay, all of which are found in the immediate neighbourhood of the works. The fuel used is hard furnace coke, made on the premises from the local bituminous coal. The process of manufacture is somewhat more elaborate than that adopted in the Thames works, much greater care and attention being necessary to ensure the production of good Portland clinker. The limestone and clays have first to be reduced to an almost impalpable powder. Their respective analyses being ascertained, it is then passed through the brush mill, from whence it is pumped into the "backs," to be eventually moulded into bricks for burning into cement in the kilns. The greatest possible care has to be exercised at the washing part of the process, by reason of the limestone and clays being so variable in quality as it is delivered into the works, an analysis of the slip being necessary every half-hour or so. Owing, however, to the different densities of the raw materials used, they settle down in the "backs" in their distinctive strata, and before the brick moulding can be done, it is necessary to thoroughly turn over the "slurry" with the shovel, and tread it well under foot in order to obtain a uniform mixture. The bricks are then transferred to the drying ovens, and in due time taken to the kilns for conversion into Portland cement clinker. Nothing but true clinker is ground at the Tongshan works. The resulting Portland cement is of great density, viz., 158 pounds per bushel. The present output is 300 tons per week, and that is the limit of the capacity of the works. It is all used at the various works of the Imperial Government, viz., harbours, forts, Yellow River Embankment, railways, arsenals, &c., very little finding its way into the hands of private consumers. There is every probability that the demand will soon be largely in excess of the existing works. The cement is guaranteed to yield a tensile strain of 400 pounds per square inch, after having been immersed in water for seven days; and as a matter of fact, it invariably tests much higher. Every day's work is tested in the following manner:—The man in charge of the grinding draws a sample from each pair of millstones every half-hour. At the end of the day the whole is mixed uniformly and taken to the testing-room. It is there tested for fineness, and twelve test briquettes are made from the same, 23 per cent. of water being used in gauging the cement. After standing in the moulds for 24 hours—note having been made of the time occupied in "setting"—the briquettes are each marked and placed under water for seven days, each being examined from time to time for any signs of blowing or shrinkage, the usual glass test being adopted as well; at the expiration of this time they are taken direct from the water and tested for tensibility and compressibility in patent cement-testing machines. If the cement passes the tests it is handed over to the storekeeper for delivery. At the time of delivery it is again sampled and tested, and a record of each test is kept. For some considerable time difficulty was experienced in obtaining cement of uniform quality. It was no easy matter to get the ignorant Chinese coolie to understand the absolute necessity of accuracy and carefulness in every stage of the process. No reliance, whatever, could be placed upon the native foreman, nor any assistance expected from them, their ideas being as lax and crude as those of the coolie. But by dint of perseverance and keeping to one set of men, something like system has been established, and the work technically proceeds with the utmost satisfaction, the output being as uniform in quality as it is possible to obtain anywhere. The fuel (furnace coke) employed in the kilns was also a great source of trouble at first. In order to effect its combustion, a very free passage of air is necessary; but unless the greatest care is exercised at this stage of process, the heat produced is so intense that complete fusion at once takes place at the very bottom of the kiln, thus shutting off all draught—in other words, the decarbonisation and subsequent fusion of the upper layers of the kiln are arrested. By the introduction of air passages throughout the depth of the kiln this difficulty has been completely overcome, and the even and uniform clinkering of the entire mass is now effected with great regularity, 48 hours being sufficient for a 90-ton charge. Owing to the severity of the winter, it is impossible to do any mixing for four months in the year, so that the output is limited to about 9,500 tons per annum. The works are in full swing 16 hours a day, including Sundays.

General Notes.

Bristol Photographic Exhibition.—The Council of the Bristol and West of England Amateur Photographic Association announce that the Triennial International Exhibition of photographs, apparatus, appliances, and processes will be held in the galleries of the Academy of Arts, Queen's-road, Clifton, Bristol, from Monday, 18th December, 1893, till Monday, 22nd January, 1894. A number of medals will be awarded by a committee of five judges.

Fruit Imports.—The imports of green fruit were very large last year, especially oranges, which showed an advance of 1,600,000 bushels over the previous year. Foreign apples were also in abundance, there having been an increased import on the previous year of 1,600,000 bushels. The Board of Trade have for the first time began to distinguish the other ripe fruit imported, 217,000 bushels of cherries being recorded last year, 413,000 bushels of plums, 637,000 bushels of pears, 764,432 bushels of grapes, and 841,000 bushels of unenumerated fruits.

Textile Industries.—The import of raw materials for our textile manufactures of cotton was nearly 2,000,000 cwt. below that of the previous year, and of the total quantity over 2,000,000 cwt. were re-exported. Of jute, the imports have fallen from 370,000 tons in 1890 to 255,560 tons in 1892, and of this quantity 87,000 tons were reshipped. Of flax, the imports have kept pretty steady during the last three years at 1,731,000 cwt., all of which is worked up in this country. Hemp has also kept pretty steady at about 1,860,000 cwt. during the last three years, of which 260,000 cwt. is re-exported. Under the classification of "hemp" is included the manila fibre from the Philippine Islands, used for rope-making, which averages now about 815,000 cwt. yearly.

Dietetic Products.—Of the popular beverages for the breakfast table, the home consumption of cocoa keeps pretty steady at 21,000,000 lbs. yearly. Coffee is stationery at about 258,000 cwt., chicory coming in largely to replace it with 93,000 cwt. Tea makes giant progress, at the advanced rate of 5,000,000 or 6,000,000 lbs. yearly, Indian and Ceylon teas forming the bulk; for out of 207,000,000 lbs. taken last year, only 33,000,000 lbs. of Chinese tea were consumed. The average is now about $5\frac{1}{3}$ lbs. per head of the population. The imports of refined sugar were about 700,000 cwt. less than in 1891, but those of unrefined sugar show a slight increase over the previous year. The quantity of raw sugar consumed per head of the population is now about $47\frac{1}{2}$ lbs., and of refined 33 lbs.

Antwerp International Exhibition, 1894.—The International Exhibition to be opened at Antwerp on May 5th, 1894, will include industrial, scientific, and artistic productions, as well as all kinds of commercial produce. It will comprise Maritime, Colonial, and African Sections; also an Exhibition of Military Art. Simultaneously with the General Exhibition, the Antwerp Royal Society of Fine Arts will hold a special exhibition of painting, sculpture, engraving, and architecture, to which artists of all countries are invited to contribute. It is also intended to hold a series of shows and exhibits of live stock, agricultural products, flowers, fruit, &c., under special regulations. The Exhibition will be situated in the new quarter of the city, near the River Scheldt and the new maritime installations. It will cover an area of about 200 acres, and will be connected with the principal railways. The main buildings will cover some 120,000 square yards of ground, and include halls for exhibiting industrial and commercial products, machinery, and electric appliances. Also a concert-hall, measuring some 6,000 square yards. The general classification is as follows:—I., Fine Arts; II., Education; III., Liberal Arts; IV., Art Industries; V., Mineralogy; VI., Engineering Construction; VII., Smaller Mechanical Industries; VIII., Electricity; IX., Textile Industries; X., Clothing; XI., Building and Home Furnishing Trades; XII., Locomotion; XIII., Chemical Industries; XIV., Food; XV. Civil Engineering; XVI., Navigation; XVII., Trade; XVIII., Art of War; XIX., Agriculture; XX., Forestry; XXI., Fisheries; XXII., Horticulture. Copies of the General Programme and circulars to exhibitors have been received from the Science and Art Department, and, so far as these extend, a copy can be obtained on application to the Secretary, Society of Arts, John-street, Adelphi.

Prizes Offered by the Societe Industrielle.—The Société Industrielle du Nord de la France offers various prizes and medals for the best papers (to be sent to the General Secretary before 1st October, 1893) on various subjects, including the following:—*Furnaces and Chimneys.*—Influence of the form and dimensions of chimneys upon the draught, with a formula for the dimensions to be adopted; forced and induced draught; gas producer furnaces, with or without regenerators, and their various applications; utilisation, as fuel, of waste substances, and the waste of poor fuels, such as sawdust. *Steam Boilers.*—Causes and effects of boiler explosions, with means of their prevention; the resistance of plates at various temperatures; an easy method of determining the per-centage of water drawn along by steam; the economical results obtained with various mixtures of coal, and different types of boilers and furnaces. *Steam-engines.*—Progress of the steam-engine and apparatus for analysing its motions; the disadvantage of wire-drawn steam; multiple expansion engines, and the effect of receivers; inverted-cylinder engines and their practical applications. *Lubrication.*—The various methods for lubricating motors and organs

for transmitting power, with the advantages and disadvantages of each, and indication of those most suitable for each purpose; comparison between the various systems of metallic packing for piston-rods, slide-valves, &c. *Joints.*—The various joints for steam, water, and gas-pipes, as regards cost, duration, &c. *Metallurgy.*—The latest improvements in the reduction of metals. *Gas Motors.*—Comparison of the various systems of gas-engines, especially as regards their yield and useful effect, and the perfection of their cycle; gas-producers for supplying motors; application of gas motors to traction and working fire-engines. *Water Motors.*—Methods for utilising as motive power the water under pressure of town supplies. *Railways.*—Various systems of locomotives for high and low speed as regards fuel consumption, steam production, speed, stability, and mounting gradients. *Electricity.*—The industrial application of electricity to the transmission of power and to lighting, with methods for generating, transmitting, storing, and transforming the electric current; and a comparison between the various methods of illumination. *Lifts.*—A complete study of the different systems of lifts or elevators for raising persons or things in dwellings, factories, &c., with the best means for preventing accidents.

THE LIBRARY.

The following books have been added to the Library since the last announcement:—

Australia, Year Book of, 1892. (London: Petherick and Co.) Presented by the Agent-General for New South Wales.

Burne, Maj.-Gen. Sir Owen Tudor, K.C.S.I.—Rulers of India—Clyde and Strathnairn. (Oxford: Clarendon Press, 1892.) Presented by the Author.

Cooley's Cyclopædia of Practical Receipts. Seventh Edition. Revised by W. North, M.A. Two vols. (London: J. and A. Churchill, 1892.) Presented by the Publishers.

Ferguson, A. M. and J.—The Ceylon Mercantile and Planting Directory, 1891-2. (Colombo: A. M. and J. Ferguson.) Presented by the Publishers.

Gilbert, Joseph Henry, LL.D., F.R.S.—Occasional Lectures and other Discourses on Agricultural Chemistry. Presented by the Author.

Hunter, Sir William W., K.C.S.I.—Bombay, 1885 to 1890. A Study in Indian Administration. (London: Henry Froude.) Presented by "A Friend of International Progress."

Imperial Institute. The Year Book, 1892. (London: Imperial Institute, 1892.) Presented by the Institute.

Kingsbury, George C., M.A., M.D.—The Practice of Hypnotic Suggestions. (Bristol: John Wright and Co., 1891.) Presented by the Publishers.

Lawes, Sir John B., Bart., LL.D. F.R.S.—Memorandum of the Origin, Plan, and Results c the Field and other Experiments on the Farm a Rothamsted. Presented by J. H. Gilbert, LL.D. F.R.S.

Loftie, W. J.—Landseer and Animal Painting i England. (London: Blackie and Sons.) Presente by the Publishers.

Lowe, Charles, M.A.—Four National Exhibition in London, and their Organiser. (London: T. Fishe Unwin, 1892.)

Martin, John Biddulph.—The Grasshopper i Lombard-street. (London: Simpkin, Marshall an Co., 1892.) Presented by the Author.

Maycock, W. Serren.—A First Book of Electricity and Magnetism. (London: Whittaker an Co., 1891.) Presented by the Author.

Mendeleeff, D.—The Principles of Chemistry translated from the Russian (fifth edition), by Georg Kamensky: edited by A. J. Greenaway. 2 vols (London: Longmans, Green and Co., 1891.) Presented by the Publishers.

Ostwald, W.—Solutions: being the fourth book with some additions, of the second edition o Lehrbuch der Allgemeinen Chemie. Translate by M. M. Pattison Muir. (London: Longmans Green and Co., 1891.) Presented by the Publishers.

Poole, Joseph.—The Practical Telephone Handbook and Guide to the Telephonic Exchange. (London: Whittaker and Co., 1891.) Presented by th Publishers.

Pye, Walter.—Surgical Handicraft. Revised an edited by T. H. R. Crowle, F.R.C.S. Thir edition. (Bristol: John Wright and Co., 1891.) Presented by the Publishers.

Savery, Charles E.—Five Designs for Villag Churches, with Descriptive Letterpress. (London Electrotype Co., 1893.) Presented by the Author.

Shaw, John, M.D.—Epitome of Mental Diseases (Bristol: John Wright and Co., 1892.) Presente by the Publishers.

Siemens, Werner von.—Scientific and Technica Papers. Vol. I. Scientific Papers and Addresses (London: John Murray, 1892.) Presented by th Author.

Spanish Chestnut, report on the cultivation of the (London, 1892.) Presented by Sir George Birdwood K.C.I.E., C.S.I.

Verity, John B.—Electricity up to Date. (London: F. Warne and Co.) Presented by the Publishers.

Watt, George, M.B., C.I.E.—A Dictionary of th Economic Products of India. Vol. VI., Part 1 and 2. (London: W. H. Allen and Co., 1893.) Presented by the Publishers.

Webber, W. H. Y.—The Science and Practice o Lighting. (London: Walter King, 1892.) Presented by the Publisher.

Wright, Herbert Edwards, M.A.—A Handy Book for Brewers. (London: Crosby, Lockwood and Son, 1892.) Presented by the Publishers.

Journal of the Society of Arts.

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FRIDAY, AUGUST 25, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

ATTENDANCES AT THE EXHIBITION.

The official figures for the admissions to the World's Fair during the three complete months that it has been open are as follows:—

May	1,050,037
June	2,675,113
July	2,762,090

The daily attendances for the first seven days of the present month are given as—

Aug. 1	80,200
Aug. 2	83,047
Aug. 3	92,692
Aug. 4	80,930
Aug. 5	106,742
Aug. 6 (Sunday)	17,181
Aug. 7, paid admissions—	
Adults (at 50 cents)	84,586
Children (at 25 cents)	4,517
Total paid admissions	89,103
Passes—	
Concessionnaires, exhibitors, workmen, and officials	35,835
	124,938

Proceedings of the Society.

CANTOR LECTURES.

THE PRACTICAL MEASUREMENT OF ALTERNATING ELECTRIC CURRENTS.

By Prof. J. A. Fleming, M.A., D.Sc., F.R.S.

Lecture III.—Delivered February 13, 1893.

The Measurement of Alternating Current Power.

Having dealt in the preceding lectures with the subject of the measurement of alternating current strength and alternating current pressure, I propose to consider now the measurement of alternating current power.

When the current is flowing through a conductor it dissipates energy, and the rate at which this energy is dissipated is spoken of as the *power* taken up in that circuit. When a constant current is flowing through a conductor, if we measure the current in ampères and the difference of potential in volts, then the product of these two numbers gives us the power taken up in the circuit measured in watts. In this case two simple measurements give the required rate of dissipation of energy in the conductor. If, however, we have to deal with an alternating current, in which the current strength is varying from instant to instant, according to a periodic law, and if likewise, the difference of potential between the ends of the circuit is varying in the same periodic manner, we cannot always obtain the measurement of the mean power taken up in the circuit, generally speaking, by taking the product of the $\sqrt{\text{mean-square}}$ ampères and $\sqrt{\text{mean-square}}$ volts. What we really require in this case is the mean value of the power taken up in the circuit. We can obtain the measurement of the mean power if we can measure at every instant the true value of the current strength and the difference of potential, supposing these instantaneous values of the current and pressure known at equidistant intervals taken throughout one complete period; if we then multiply the instantaneous value of the current by the corresponding value of the pressure, or difference of potential, and multiply these together, we obtain a number representing the instantaneous value of the power, and if we imagine the period divided into a large number of equidistant intervals of time, and those products taken at every such instant, then the mean value of these products, taken throughout the period, would give us a close approximation to the mean value of the power being absorbed by that circuit.

We have seen in a previous lecture how it is possible to determine and describe curves representing the instantaneous values of the current and electromotive force in the case of an alternating current circuit, but this in general is not a simple matter to do, and we have therefore to resort to other methods of obtaining the required result.

In dealing with the power taken up in alternating current circuits, there are two cases to be considered.

The first case is that in which the circuit is non-inductive. In that case, as before ex-

plained, the impedance of the circuit is the same as its resistance, numerically speaking. For such circuits the alternating current flowing in the circuit is in step, as regards phase, with the alternating potential difference between its extremities. When this is the case the power taken up in that circuit can very easily be measured. If we measure the $\sqrt{\text{mean-square}}$ value of the alternating current by means of any of the balances of dynamometers described in the first lecture, and if by means of any of the electrostatic or thermal voltmeters we measure the $\sqrt{\text{mean-square}}$ difference of potential between the ends of the circuit, and multiply these two mean-square values together, we obtain the mean value of the power taken up in the circuit, and we arrive at the same result as if we had been able to measure separately the instantaneous values of the current and potential difference at numerous equidistant intervals throughout the phase and taken the mean value of their products.

As an instance of this, it may be pointed out that an incandescent lamp may be treated as a practical non-inductive circuit. If this incandescent lamp is traversed by an alternating current, and we measure the current flowing through the lamp by means of, say, a Siemens dynamometer, the potential difference between the terminals of the lamp by means of, say, a Cardew voltmeter, and if we multiply the two scale readings of these instruments together, we obtain the mean value of the power measured in watts, taken up in the lamp.

So far then all is quite simple, and in dealing

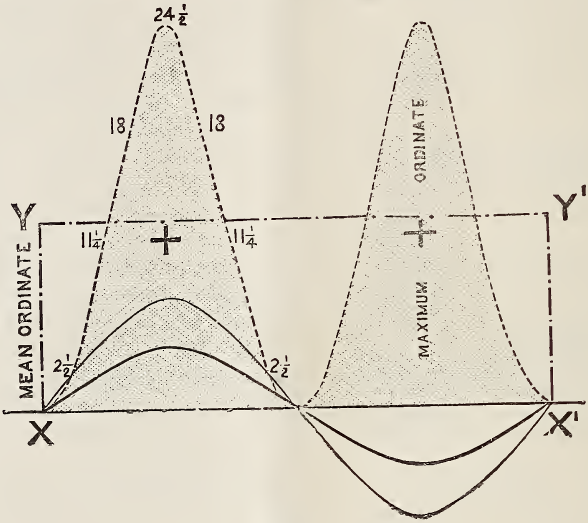

FIG. 1.

with any circuit which we know or can prove to be practically non-inductive, we have no difficulty, by means of two instruments of the proper kind, in determining the real mean-power taken up in the circuit. Our difficulties come in when we have to deal with circuits such as transformers, which, when not fully loaded, we know to be inductive. If, in this case, we can determine the instantaneous values of the current and difference of potential between the ends of the circuit, then, proceeding as above described, we can determine the mean value of the power taken up in the circuit. If, however, it is not convenient to do this, we cannot proceed to measure the $\sqrt{\text{mean-square}}$ values of the current and electromotive force, and then multiply them together. Such a proceeding would lead to a considerable overestimate of the real power taken up in the circuit. Without going into elaborate proof of this, it may be simply sufficient to present the following figures :—

In Fig. 1 are shown two simple harmonic curves in step with one another. The semi-period is divided into eight equidistant parts, and ordinates are erected at each point. The values of these ordinates for the two curves, which may be taken to represent periodic current and electromotive curves, are given below the diagram. By squaring each of the values of the ordinates, and taking the square root of the mean of the squares, we obtain for each curve a number which would represent the instrumental value obtained by an alternating

current dynamometer or voltmeter. If we multiply together the simultaneous values of current and electromotive force, we obtain a number which represents the instantaneous value of the power taken up in the circuit, and if we take the mean value of all these separate instantaneous values of the power, we obtain the same number as we do if we take the products of the square roots of the mean of the squares of the instantaneous values of the current and electromotive force. Hence, we see that when the two simple harmonic curves are in step with one another, the product of the square root of the mean of the squares of the separate ordinates is equal to the mean value of the products of the corresponding ordinates.

In Fig. 2 are shown two periodic curves, which may be taken to represent a current and an electromotive force curve, but one of which is displaced backwards relatively to the other. This is what happens in an inductive circuit, where the periodic current always lags in phase behind the periodic electromotive force.

If we perform the same operations on the ordinates of these curves, we find that a product of the mean square values is in excess of the mean of the products. In other words, if in such circuit we measure the current by means of a dynamometer, and the potential difference between the ends by means of an alternating current voltmeter, the product of these two numbers gives us a number which is in excess of the true value of the mean-power taken up in the circuit.

It is convenient to call the product

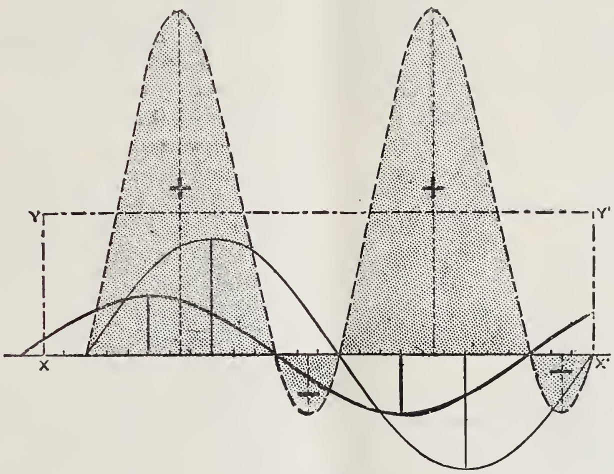

FIG. 2.

of the $\sqrt{\text{mean-square}}$ ampères and the $\sqrt{\text{mean-square}}$ volts the *apparent watts* taken up by the circuit, and to call the true mean value of the power the *true watts* taken up by the circuit.

The ratio between the true watts and the apparent watts is called the *power-factor* of the circuit. Thus, for instance, in the case of a transformer or open circuit, the transformer being of the closed magnetic circuit type, the power factor is about ·7, in other words, the real power is only $\frac{3}{4}$ of the apparent power. In the case of a transformer of the open magnetic circuit type, the power-factor may be as small as ·1. Hence you see that an enormous error in this case would be committed by taking the product of the instrumental readings as simply representing the true mean power taken up in the circuit. We have, then, to consider in what way this true mean power can be practically measured in the case of alternating current circuits.

There are many methods by which this may be done. A large number of methods have been described which look very excellent on paper, but which do not in practice turn out so well. As I desire only to bring under your notice those methods which are capable of being practically employed, I shall pass over the theoretical methods, and turn at once to the description of those instruments which will enable us to measure practically the power taken up in inductive circuits. The most practical, and by far the best instrument to use for this purpose is the electro-dynamometer instrument. Consider a dynamometer, such

as one of the Siemens dynamometers described to you in my first lecture. Let the fixed coil of this dynamometer be placed in series with the circuit in which we desire to measure the power being taken up. Let the movable circuit of the dynamometer consist only of a few turns of wire, and let this movable circuit have joined in series with it a non-inductive resistance, which may be formed either of coils or wire, or incandescent lamps. Let this movable circuit with its added resistance be placed as a shunt across the ends of the circuit in which it is required to measure the power, being joined up as shown in Fig. 3. Then when the alter-

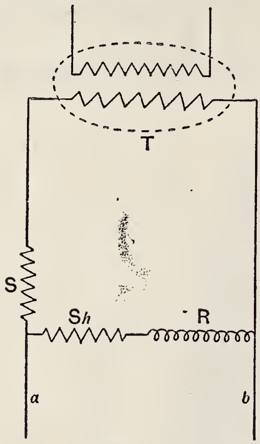

Fig. 3.

nating electromotive force is applied to the circuit, the fixed coil of the dynamometer (now called a wattmeter) will be traversed by a periodic current identical with that passing through the inductive resistance. The movable coil of the wattmeter will be traversed by a current which will be in step as regards phase with the potential difference between the ends of the inductive circuit. When the dynamometer thus has its two circuits traversed by two currents, the force required to hold the movable circuit in its normal position against the electro-dynamic forces, is at any instant proportional to the product of these currents. If then the currents vary from instant to instant, and if the time of vibration of the movable coil is very long compared with the periodic time of the current, the mean value of the force required to hold the movable coil in its normal position with its axis at right angles to that of the fixed coil, will be proportional to the mean value of the products of the currents in the fixed and movable coils respectively, that is to say, will be proportional to the mean power being taken up in the inductive circuit. The force required to hold the movable coil in its normal position may be furnished by the torsion of a spring, and hence we can with such an instrument, read off the mean-power being taken up in the inductive circuit, provided that the wattmeter is already standardised. The best way to standardise the wattmeter is to apply the watt meter to measure the power taken up in a known standard non-inductive circuit, and, at the same time, to measure the mean-square value of the current flowing through this circuit and $\sqrt{\text{mean-square}}$ value of the potential difference between its ends. In this way we apply the wattmeter to measure the known power being taken up in a non-inductive circuit, and we then obtain the constant of the instrument.

The conditions of success in the use of this wattmeter are as follows:—

1st. The current through the series of coil of the instrument must have the same value as the current through the circuit to be measured, and the current through the shunt coil of the watt meter must be exactly in step with the difference of potential between the ends of that shunt circuit; in other words, the shunt circuit must be strictly non-inductive. This can only be secured by winding the movable coil of the wattmeter with no very great number of turns.

On the other hand, we then have to face another difficulty when we employ such a wattmeter to measure the power taken up in the primary circuit of transformers at high pressure. In this case, in order to obtain the sufficient magnetic moment in the movable circuit of the wattmeter, we are obliged to pass a relatively large current through the shunt circuit, and then we find that we are wasting a large amount of power in this shunt circuit. Unless this power is at disposal, it may prevent us from practically employing this method. But, fortunately, there exists another method of dealing with the matter.

In my first lecture I pointed out to you that when a transformer is being worked on open secondary circuit, or is very lightly loaded, the potential difference between the ends of the primary circuit is exactly opposite in phase to the secondary circuit of the transformer, of which the primary circuit is connected to the extremities of the circuit in which the power to be measured is taken up (see Fig. 4, p. 869). We shall still have an arrangement in which the current in the shunt circuit of the wattmeter can be made to be in step with the

potential difference between the ends of the inductive circuit, all other arrangements remaining the same, but in which the total power taken up in the wattmeter is very much less than in the former case.

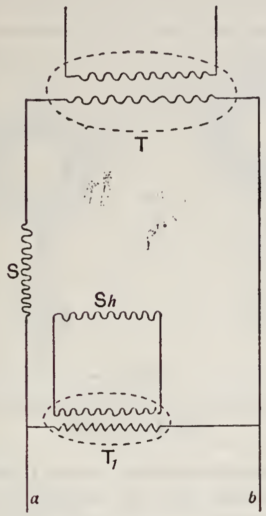

FIG. 4.

To show the difference between these two methods, let us suppose that in the first place the wattmeter had a shunt resistance which could carry suitably one ampère, and that it is required to use this wattmeter to measure the power taken up in the primary circuit of the transformer at a pressure of 2,000 volts. We should then have to provide a non-inductive resistance capable of carrying 1 ampère at 2,000 volts, or nearly 2,000 watts expended on it. Under these circumstances, the power wasted in the shunt circuit of a wattmeter would be nearly 3 h.p. If, however, we do away with the non-inductive shunt resistance, and take a 1 h.p. transformer capable of transforming down from 2,000 to 100 volts, and put the shunt coil and the wattmeter together with a small additional resistance across the secondary terminals of this transformer, so arranging the resistance that still one ampère flows through the shunt circuit of the wattmeter, we then have the following power absorptions :—

The wattmeter shunt circuit will absorb 100 watts, and the transformer can be made to take as little as 60 or 70 watts, hence the whole arrangement, transformer, watt meter, and additional resistance only takes up 150 watts instead of 2,000; in other words a saving of 92½ per cent.

It is clear, therefore, that the combination of the wattmeter with the transformer in this fashion is more economical than the use of a non-inductive external resistance. Generally we may then say, that for the purpose of measuring alternating current power, the best instrument to employ is the dynamometer wattmeter; using either one of the Siemens' form, in which the torsion of a spring is employed, or a balance form similar in construction to the ampère balance of Lord Kelvin. In those cases in which the potential differences between the ends of the circuit in which we wish to measure the power absorption does not exceed 100 volts the whole, the necessary resistances can be placed in the movable coil itself, winding it at a high resistance, so that we have as few turns as possible in that coil and yet obtain the necessary magnetic moment. We can then apply the wattmeter, standardised as above described, to measure the power taken up in any circuit inductive or non-inductive. Many such instruments, lent by Messrs. Siemens Brothers, Messrs. James White, of Glasgow, and others, are before me on the table.

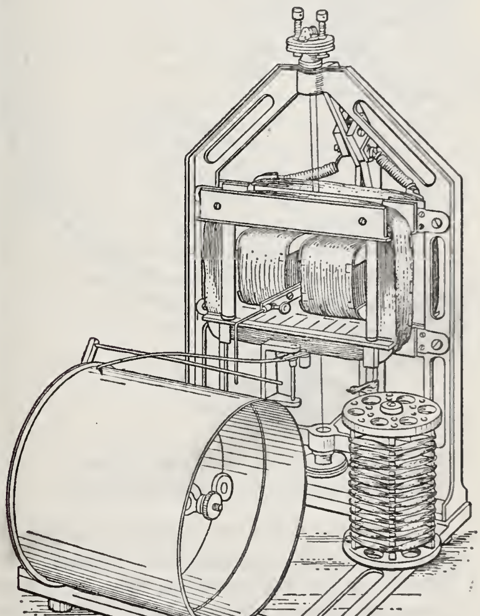

FIG 5.—MENGARINI WATTMETER.

When we have to measure the power taken up by any inductive circuits, particularly when we are employing high pressures, as in measuring the power absorption in the

primary circuit and transformers; then the best method to adopt is to use a transformer in connection with the dynamometer watt meter, as above described.

There is before me one interesting and novel form of wattmeter, for use on alternating current circuits, which has been lent to me by Lord Kelvin. The instrument consists of a coil of one or two thick turns of copper wire, and a spectacle-shaped fine wire coil in series, with an external resistance. The instrument is adapted as a central station wattmeter, giving indications of power passing through it by means of the movement of a needle attached to the fine wire coil over a scale.

The interior is shown in Fig. 6. It has a

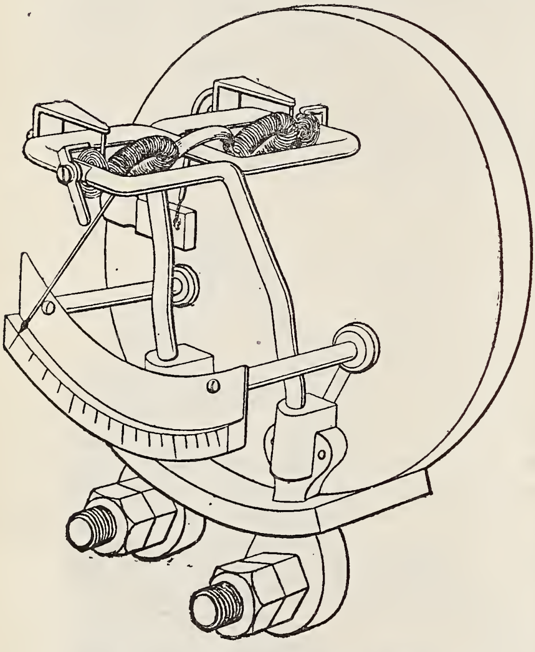

FIG. 6.—ENGINE-ROOM WATT METER.
General view of instrument, with case removed.

main circuit formed of a double rectangle of copper rod having sufficient area to carry 200 ampères, and a shunt circuit with two fine wire coils astatically arranged. The main coil is mounted on a slate back so that the rectangles are horizontal. The shunt coils are mounted on a light but strong aluminium frame in the manner shown in Fig. 7. One end of this frame has a circular knife-edged hole fixed to it, and the other end has a straight knife-edge. These two knife-edges rest on two phosphor-bronze hooks attached by insulating supports to the outside ends of the double rectangle. By this method of suspension complete freedom from friction is obtained, while the movable system is kept in a definite position without end guides.

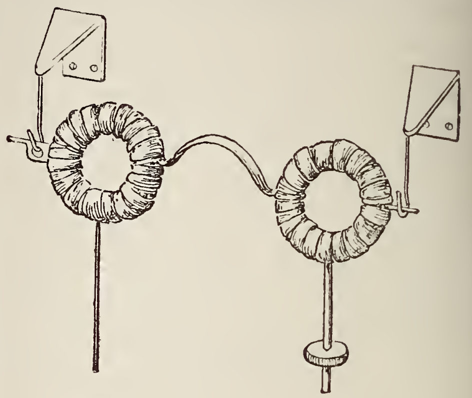

FIG. 7.
View of fine-wire shunt coils, showing details of suspension-springs removed.

Each fine wire coil has about 1,000 turns of insulated wire, and its resistance is about 100 ohms. The current is conducted in and out from the movable system by two flat palladium spiral springs, which also supply the restoring force for governing the sensibility of the instrument. Not more than 1-20th of an ampère is allowed to pass through the fine wire circuit, and in order to regulate this, a large non-inductive resistance is rolled on the case of the instrument, which offers a large cooling surface. The scale has nearly uniform divisions, and is graduated to read directly in watts or kilowatts as required.

Miscellaneous.

THE NEWSPAPER PRESS IN CHINA.

A report has recently been made to the Geographical Society of Paris by M. Imbault-Huart, French Consul at Pekin, upon French journalism in China, a subject which had never hitherto, it is said, been treated in so detailed a manner. The author commences by observing that, in China, it is the official gazette that has preceded all other journals. The *Gazette* of Pekin, which is the name given to this paper by foreigners, although its Chinese title is *Tçing-paô*, meaning news of the capital, is the official organ of the Government, and it existed in the year 713. This paper publishes three editions, the first of which is exclusively

official. A number of this edition is composed of from ten to twelve double sheets of yellow paper, printed on one side only; each page, about 18 centimetres long and 10 centimetres wide, is divided into seven columns, marked by lines in violet ink. The first page, or sometimes the first two pages, contain the *resumé* of a register kept at the Imperial palace, and in which a careful record is kept of the Imperial audiences, presentations, changes of residence of the Emperor and Empress and their movements, such, for example, as visits to the various temples and other shrines. On the third page appear the names of those members of the various administrations, officers, &c., who are on duty at the palace on the day that the paper appears. Then come the Imperial decrees, some of which are issued by the sovereign personally, and some suggested by the reports of the high provincial authorities; then the reports addressed to the Emperor, by the various Ministers, and by the viceroys, or provincial governors; the reports from the Pekin Prefecture of Police upon the events and incidents occurring in the capital. For some years—and, it may be said, for some centuries—only the *Gazette* was in existence as a newspaper, but, at the present time, the Chinese papers now appearing are the following:—At Shanghai, the *Chen-paô* (News of Shanghai), established about 20 years ago; the *Hou-paô* (News of Hou), dating from 1883 (Hou is the classical and literary name for Shanghai); at Tientsin, the *Che-paô* (News of the Day); at Canton, the *Kouang-paô* (News of Kouang-toung), established about 10 years ago, and the *Ling-nam-jé-paô* (Daily News of Ling-nam); Ling-nam is the ancient name of the city of Canton. All these papers have for their editors Chinese literary men, and the printers are native workmen. The *Chen-paô*, or *Shanghai Gazette*, may be taken as a prototype of the Chinese paper. It is printed on thin paper, and the size varies according to the abundance or dearth of matter. The leading articles are well written in the modern style, and in them are treated all the questions of the day; for example, the *Cheng-paô* wrote very exhaustively upon the Pamir question, at the time it was occupying so much attention in the St. Petersburg and London press, and it dealt with it from the Chinese point of view. After the leading articles come the Imperial decrees, the most important of which are transmitted to Shanghai by telegraph; then those reports which contain information likely to interest the general public, addressed by the provincial authorities to the Emperor. Miscellaneous news follow this section, and this category comprises the *on dits* of the city—murders, suicides, fires, inundations, births, deaths, and marriages, criminal and civil proceedings, bankruptcies, and sport, to the latter of which, M. Imbault-Huart says, considerable attention is devoted by the Chinese. The paper also contains items of news translated from English papers, Reuter's telegrams, proclamations of Chinese authorities, correspondence from the provinces, and reports of the proceedings of the mixed courts. These Chinese newspapers cannot, any more than those of the West, dispense with the services of the reporter, but the profession of the latter is said to be of very recent introduction. The mission of the reporters of the Chinese newspapers appears to be to pick up news in the streets, in houses, and in the *yamen*, or palaces of high functionaries, the dwellings of magistrates, &c. They are met in every place that information or any subject of general interest is likely to be obtained. In cases of murder, fire, or riot, they are the first on the scene, and, if necessary, they disguise themselves. They penetrate into the houses of persons of distinction and encourage their servants to discuss the affairs of their masters. In China, business discussions are carried on round a table, on which are placed tea, wine, cakes, fruit, &c., and during the interview, no matter how important it may be, a crowd of persons are walking round, who listen attentively to what is going on, so that the public is not kept long in ignorance of the details of the conference. Although the reporter occupies a position in Chinese journalism, the "interview" has not yet been introduced, and this has not, as yet, formed a feature in the Chinese papers. Advertisements appear on the last page, together with the notices of the theatres and other places of amusement. As regards advertisements, foreign merchants at the outset were the only ones who availed themselves of this method of bringing their goods under the notice of purchasers; but it was not long before Chinese business men began to recognise the importance and usefulness of advertising, and so followed the example of the foreigners. Among the advertisements in a recent issue of the *Chen-paô* were many in connection with pharmaceutical preparations, both Chinese and foreign, arms and ammunition, machinery, life and fire insurance companies, book sales, land sales, &c. M. Imbault-Huart says, that in his study of Chinese journalism, he was impressed with a curious fact, namely, the evolution of the Chinese language, brought about by the spread of journalism. In order to render new ideas, and to explain modern inventions, it has been found necessary to coin words hitherto absent from the Chinese vocabulary. In place of having recourse to a long and slightly incomprehensible periphrasis, hitherto the only means of rendering a foreign word, it has been considered sufficient to phonetically transcribe the latter—to dress it up, as it were—in Chinese, and to introduce it thus into the language. As an example, the following words may be quoted:—"Ou-li-ma-toung" (ultimatum), introduced during the Anglo-Chinese conflict); "ssen-ta-tou-ko," phonetic transcription of the expression *statu quo*; "to-li-foung," under which may, with difficulty, be recognised the word "telephone." These words are all written in Chinese characters, which ordinarily have a precise significance, but which, in these transcriptions, only play a part which is purely phonetic.

BANANA CULTIVATION IN HONDURAS.

Within the last few years the business of growing and exporting tropical fruits, and especially the banana, on the north coast of the Republic of Honduras has grown to vast proportions. The soil and climate of that portion of the country seems to be especially adapted to this industry. La Ceiba, situated between Puerto Cortez and Truxillo, has become one of the most important ports of the country solely through the banana trade, which finds an outlet there for the United States. The United States Consul at Tegucigalpa reports that the north coast of Honduras is favoured by its geographical situation, which places it within easy communication with the rest of the civilised world, and is also blessed with a soil of unsurpassed fertility. The coast is now the centre of the fruit trade and offers abundant facilities to those desiring safe returns for money invested. Settlers from the United States, and from Europe can establish their homes and reap a crop within eight months after their arrival. The cultivation of tropical staples, such as bananas, cocoanuts, coffee, sugar, &c., is easy, and requires but little outlay. Many foreigners and natives have already embarked in this kind of business, and the trade of exporting fruit, which began with a little schooner about ten years ago, occupies three lines of steamers and sixteen sailing vessels, which regularly visit the north coast of Honduras to load with bananas and all kinds of fruit destined for the American market. The banana production of Honduras amounts now to several million of bunches a year. The steamers carry from 8,000 to 15,000 bunches, which they generally buy at from three to twelve reals (8 reals = 4s. 2d.) a bunch on board. The fruit trade is yet in its infancy; only a small part of the coast between Ornoa and Truxillo has been cleared and planted, while millions of acres of the unoccupied fertile lands are yet covered with tropical bush and forests. East of Truxillo little or nothing has been done, yet the coast offers the same facility for fruit growing as the western portion of the north coast. Nothing, it is stated, is easier than to start a fruit farm on the Honduras coast. Having first selected a good point, as near as possible to some navigable stream, where the soil is rich and deep, the planter gets his land cleared of the bush and woods which cover it. The *peones* from the interior perform this operation with axes and *machetes*. Two men will clear a *manzana* of heavily timbered land in 15 days (a *manzana* is equivalent to about 100 square yards), and the rubbish is left to dry, so that it can be burned, which may be done after one month, and as soon as the fire has done its work, the land is ready for cultivation. The *matasa*, or suckers, are obtained from old plantations; they are generally bought at about one shilling a hundred. In one *manzana* about 400 plants may be planted, about five yards apart. A labourer with an *azadón*, or spade, can easily make the holes and plant 200 *maiza* in a day. Once in the ground, the banana takes care of itself; its growth is extremely rapid, and within nine or ten months each plant gives one bunch. When cutting the bunch for the market, the plant itself is cut near the ground, and soon several suckers spring up on each side of the old stump. It is advisable to reduce the number of these suckers to three or four per *mata*, as the fruit will turn out of better quality. In about six or eight months each of these shoots will give a bunch, which is cut down, so that new suckers spring up and keep on producing fruit for a period of about seven years, when it is usual to burn down the worn-out plantation and let it rest, afterwards utilising it for some other kind of fruit cultivation. It is estimated that a *manzana*, which costs $30, will yield $325, a profit of 1,000 per cent. And this does not represent the whole of the profit, for the fruit, which is now only shipped to the United States in its natural condition, could be prepared, preserved, dried, or turned into flour—banana bread is already used in Chicago—and all these industries could be established on the Honduras coast, giving remunerative employment to the labourers of the country and safe investment for foreign capital. Under the agricultural laws of the country, national lands may be obtained free of cost, provided they are settled in good faith, and a certain amount of work is done in the nature of improvement and planting. This provision applies to the interior lands; the coast land, to a distance of twelve leagues inland, may be purchased at a cost of $2 per *manzana*.

THE SALT INDUSTRY OF ASTRAKHAN.

H.M. Consul at Taganrog has recently addressed to the Foreign-office a report upon the salt industry of the province of Astrakhan, which is of some interest, as he believes that this particular industry in Astrakhan has not been dealt with before. The Trans-Volga steppes, in the province of Astrakhan, represent an extensive salt basin, composed of the largest known salt lakes, viz., Elton and Baskunchak, a whole group of so-called South Astrakhan salt lakes, and large beds of rock salt in the Chapchachi Hill. At the present moment, the salt is extracted from the Baskunchak and South Astrakhan lakes. The work at the Elton Lake has been discontinued since 1882, and the Chapchachi Rock Salt Works were closed in 1885. On referring to the annals of the salt industry in these parts, it is found that it has not developed steadily, but, on the contrary, it has had many ups and downs, owing, not so much to the quality of the salt or the producing capacities of the lakes themselves, as to the usual conditions and state of trade and industry, attention being directed first to one group and then to another. One great factor in the development of the salt industry was the establishment of steam communication on the Volga,

and a diminution in the cost of transport. The salt was first worked at the Astrakhan lakes at the time that Ivan the Terrible conquered that province; but after the nomadic Kalmuks became Russian subjects, in 1665, the industry was gradually transferred to the Elton Lake, and from 1747, it was generally concentrated in that locality, lasting until 1882. For 116 years the lake was worked by the Government, but from 1866 to 1882 it was in the hands of private individuals. The Elton Lake is one of the most extensive and richest salt lakes known to exist, and covers an area of 135 square miles. The thickness of the salt bed is, up to the present day, unknown. As far back as 1805 attempts were made to dig a well, but the work had to be abandoned at a depth of 14 feet owing to the hardness of the salt and foul air, which prevented the labourers from stopping down more than ten minutes at a time. This unsuccessful attempt, however, still proves that the layer of salt in the Elton Lake is at least 14 feet thick, and consequently contains a stock of several hundred million tons. According to the analysis of Professor Fedchenko, the Elton salt is composed as follows:—Chloric natron, 95·507 per cent.; chloric magnesium, 0·460 per cent.; sulphate of magnesia, 1·137 per cent.; sulphate of lime, 1·482 per cent.; and water, 0·969 per cent. The salt was worked by primitive means, the only tools used being crowbars, pickaxes, and spades, and was transported to the shore on specially constructed rafts, carrying about one ton or two tons and a half. The cost of working one poud (36 lbs. English) of salt at the time the lake was held by the Government was 1½d., and the salt was sold on the spot at 6¾d. per poud to 7d. per poud. On the transfer of the lake to private management, the cost of production was reduced to 1¼d. per poud. The Baskunchak Lake, second in size to Elton, extends over an area of 66 square miles. Surveys made in 1883 prove the bed to be from 20 to 28 feet deep, and the analysis made by Professor Fedchenko shows as follows:—Chloric natron, 97·436 per cent.; chloric magnesium, 0·403 per cent.; sulphate of magnesia, 0·132 per cent.; sulphate of lime, 0·659 per cent.; mineral matter insoluble in water, 0·373 per cent.; organic matter, 0·157 per cent.; and water, 0·782 per cent. The mode of extracting the salt is similar to that practised at the Elton Lake. Blasting with dynamite was introduced in 1877, but it is very rarely resorted to, and its use has never been efficiently adopted. The salt industry of the Astrakhan lakes is chiefly concentrated in the south-west of Astrakhan, in the neighbourhood of the Nicolaievka, Liteinaya, and Bassova villages. Here there are altogether over 70 lakes, more than half of which are being worked. Taking into consideration their size and the quality of the salt produced, the following are the principal lakes:—Basinsk, Kistel-Khan, Great Betlouk, Little Betlouk, Great Bantakak, Guravinsk, Great Korduansk, and Bogoroditsko-Don. The supplies of salt from these Astrakhan lakes are, as compared with Elton and Baskunchak, insignificant, and it has been remarked that, with an increased production, the salt immediately deteriorates, both in quantity and quality. For instance, the salt from the Great Basinsk Lake, according to analyses made from 1825-56, contained 93·89 per cent. of chloric natron, but after being worked for some time, especially during the last few years, when larger quantities have been extracted, the per-centage dropped to 84·79 per cent. This decline is explained by the fact that in working the evaporated salt all the bitter magnesia salts are washed out by the brine, and in this manner remain in the lake. The salt is extracted in the same primitive manner as at the lakes before mentioned. The Chapchachi rock salt bed consists of a solid mass of rock salt comprising the Chapchachi Hill, and is about 53 miles to the south of the Baskunchak Lake, 57 miles east of the Volga, and about 97 miles from the town of Astrakhan. The Chapchachi Hill is only about 90 feet high, its length is about two miles, and breadth 4,900 feet. According to surveys made, the salt strata is about 280 feet thick, but the total quantity of salt has not yet been determined.

EMBROIDERIES OF ST. GALL.

The value of the machine-made embroideries of Eastern Switzerland is estimated at about £4,000,000 annually, and according to recent reports the industry appears to be increasing. For nearly 100 years St. Gall was the centre of the manufacture of the celebrated Swiss hand embroideries. Machines for producing embroideries were introduced into Switzerland at the close of the first quarter of this century. Beautiful and cheap as were the hand embroideries, the machine-made article soon began to take their place, and to-day not more than 5 per cent. of the world's embroideries are made by hand. The machines are still operated by hand, but steam machines have recently been invented, but these machines are being thoroughly tested by experts. Opinions differ in regard to them, but there is scarcely a doubt that in the near future they will revolutionise the embroidery industry and drive the hand machines out of the trade. There are about 24,000 hand embroidery machines in use in Eastern Switzerland. Each machine has about 250 needles, and each needle averages not less than 2,000 stitches daily. The average daily wages of an embroiderer operating one of these machines is about 2s. The following is a short sketch of the development of the machine embroidery industry in Switzerland. In the year 1827 two embroidery machines made by the inventor, Heilman, were purchased and set up in a small workshop at St. Gall. Attempts to manufacture marketable embroideries with these machines were unsuccessful until 1850, when a number of impravements were made. The first machine-made

embroidery was exported in 1854 to America, where it was sold under the name of "Hamburgs," and a flourishing trade in embroidered goods was interrupted by the civil war in America, but was resumed and extended after 1865. In the meantime the machines had been perfected so as to allow of the manufacture of figured and dotted patterns of curtains and other goods. The great American demand for Swiss embroideries resulted in a general increase in the number and output of the factories in the St. Gall district. From 1865 to 1875 was the period of the greatest prosperity of this industry in Eastern Switzerland. Wages were high, and working men were attracted from other trades and other parts of the country. In 1872, the Appenzwell brocades and damasks and the chain-stitch curtain embroideries were beginning to be drawn out of the market by the competition of the lace workers of Nottingham. The invention of the one needle chain-stitch machine and its introduction into Germany brought further competition of an inferior product, at greatly reduced prices. The embroidery industry gradually became diverted from large factories to the houses of operatives, where one or two machines were run for very long hours. The goods thus produced were sold at prices below those of the large manufacturers, forcing the latter to retire from business. The trade fell into the hands of the merchants, who furnished patterns and disposed of the goods turned out by the embroiderers at their homes. In the spring of 1876 there came a general reaction caused mainly by over-production. Wages of embroiderers fell over 40 per cent., and have never since reached their former figures. In 1882, a short period of prosperity resulted from a change in the fashions, which caused an increased demand for certain styles of lace goods, but an overproduction of these articles soon followed, and again many factories were closed. About this time the "shuttle machine," on which tulle embroideries are cheaply manufactured, was invented, and has since competed seriously with the older machines. The most noticeable of recent changes has been the enormous increase in the number of lace handkerchiefs exported to America, as many as 700,000 dozen having been sold in a single year.

THE MINING INDUSTRIES OF HUELVA.

The British Vice-Consul at Huelva says that, when the enormous mineral deposits of the Province of Huelva, included in the metalliferous zone which stretches in mountain ranges of varying altitudes, from the River Guadalquivir to Setubal, on the coast of Portugal, were first worked is not known for certain, but it is thought that, although the Phœnicians are the earliest people who have left indisputable traces of their mining operations, the mines were worked, to some extent, by the Iberians before the arrival of the merchants of Tyre. The ancient slag from the smelting ovens shows two different methods of working. The older, left by the Phœnicians, is spread out into low heaps of large extent, rough, and badly smelted, containing up to 2½ per cent. of copper; while the Roman slag, deposited in high heaps, shows that the smelters had waited for its more convenient removal and deposit; and it differs from the older slag in the regularity of its composition, and in its being perfectly smelted; it only contains about half per cent. of copper. The Carthaginian wars apparently paralysed the mining industry of this district, but it received a new impetus from the Romans, who worked the mines until the fifth century. The invasion of the Goths put an end to the mining industry of the province, and there are no signs whatever of the mines having been worked under the Moorish dominion. The revival of mining operations appears to have dated from about 1560 to 1650, during which time a great number of mines were denounced and registered, but with the curious coincidence of being generally registered as containing gold, silver, copper, and other metals. In 1725 a company was formed for working the Rio Tinto mines, which, some years later, appear to have been in a flourishing condition, but, falling into the hands of the Government, it seems to have been greatly impeded in its operations through politics. The beginning of the present great mining industry dates from 1853, when Tharsis and Calañas (the third largest mine in the province) were registered. A company was formed to explore them and clean the old workings, but the cholera epidemic of 1854 put a stop to the work, and the company was dissolved. Another company was formed in 1855, with a capital of £240,000, and two years later there were 2,500 men working at Tharsis, and as many as fifty ships waiting for ore at one time in the port of Huelva. In 1862, Tharsis was capable of producing from 8,000 to 9,000 tons of ore per month, and works were erected capable of treating from 5,000 to 6,000 tons monthly. Contemporaneously a large number of the mines were registered and began working. From 1859-62 some large and important mines were already being worked, such as Azualcollar, Buitrom, and Lagumazo. At this time they had to contend with a fall in the price of copper and the heavy customs duty on the pig-iron used for making the precipitate of copper. The large mine, Santo Domingo, in the same zone, but in Portugal, not being hampered by duties, and having constructed a railway to the shipping place of La Laja, in the River Guadiana, had raised its extraction to 5,000 tons annually. The next forward movement was the conversion of the French Tharsis Company into a strong company, with its head office in Glasgow, and the construction of a railway to Huelva, and shipping pier in 1867-8, and the purchase of the Rio Tinto mines by an English company, who constructed a railway to this port, a distance of fifty-three miles, also a shipping pier in 1873-74. These

companies have reached a yearly production of about 500,000 tons, and 1,500,000 tons respectively. With the other mines, the total production of the province is nearly 2,600,000 tons of pyrites. The manganese mines are very numerous, and the quality very good, but there is not a brisk demand for it. North of the copper zone are two zones of ores containing silver. The more southerly zone contains silver and antimony mines, with veins from half to three-quarters of a metre wide, and 60 to 150 ozs. of silver to the ton. North of these the mines are silver lead, containing 30 ozs. to 150 ozs. of silver, and 45 per cent. to 65 per cent. lead. These ores have not yet been shipped to any great extent. There are also mines of antimony without silver, containing from 50 to 55 per cent. of antimony, clean and easily wrought.

THE SARDINE FISHERY OF BRITTANY.

The catching and preserving in oil of the sardine is one of the most important industries of Brittany. The United States Consul at Nantes says that along the coast from Les Sables d'Olonne (Vendée) to Camaret (Finisterre) there are about 150 canning factories. During the sardine fishing season, which lasts about five months, 2,500 boats, equipped with from 12,000 to 15,000 sailors, are employed. The *employés* of the factories number about 10,000 women and children, and from 1,500 to 2,000. The annual expenditure for labour, material, &c., amounts to about £775,000. The industry originated in Nantes in the year 1834, and the best brands are still those of that city. These brands are imitated in Spain and Portugal but are of inferior quality, owing to the use of Spanish instead of Italian oil. The sardine is a migratory fish, which first appeared on the coast of Africa, passing northward in large shoals, following the coast of Portugal, crossing the Bay of Biscay, and striking the coasts of Vendée in the month of April or May. Here the sardine is met by fishermen stationed at the seaport town of l'Isle-d'-Yeu, and in the bays of the Sables d'Olonne and of Saint Gilles, who assemble from all parts of Britanny and follow the fish toward the north, retarding its progress with a special bait called *roque*. Before daybreak the fishing boats leave port to search for the shoals of sardines; many leave in the evening and anchor at sea. When a peculiar bubbling of the water reveals the fish, the nets are immediately thrown. Each net is from 900 to 1,000 yards in length, about three yards in width, and black in colour. On the upper part of the net are cork floats, and on the lower part leaden sinkers to keep the net in an upright position. The oarsmen, generally two in number, row always either against the wind or the tide. One man casts the net as the boat advances, while another throws the *roque* into the water. This bait is an important feature of the sardine catch, as it is expensive, and fishermen often lose considerable quantities of it. It is made of the eggs of codfish or mackerel mixed with clay, and costs from 30s. to £3 10s. a barrel. This bait is thrown into the water in small balls, which slowly dissolves and sink. At nightfall the boats return to port, where they sell their fish to the canners at prices varying according to the abundance of the catch and the size and freshness of the fish. Sales are made by the "thousand," but this term does not always indicate exactly a thousand sardines. For example at Belle Isle, 1,240 fish are supposed to make a thousand. Factories for preserving sardines are located at all the ports, for the fish spoil easily and cannot bear transportation. The fishermen convey the sardines to the factories in baskets. The process of canning sardines is as follows:—Ths sardines are spread on floors and salted and the heads removed. They are then thrown into brine where they remain half an hour. They are next washed in clear water and dried on screens. This work is done almost entirely by the wives and children of the fishermen, their united wages during the fishing season enabling the family to subsist during the following winter. After the fish have been thoroughly dried they are cooked by dipping them for a few minutes in oil heated to 212° Fahrenheit. They are again drained and handed over to workmen, who pack them in small tin boxes, which are filled with pure olive oil and then soldered. The oil used is imported from the province of Bari, Italy. The boxes are next thrown into hot water, where they remain for two or three hours, according to the size of the boxes. When withdrawn, the boxes are first cooled, then rubbed with sawdust to cleanse and polish them, and packed in wooden cases of 100 boxes for shipment. During their immersion in the boiling water oil will escape from all boxes not properly soldered. In such cases the loss is sustained by the solderer. A good workman rarely misses more than two or three boxes per hundred. A quality of sardines, called "boneless sardines," is prepared especially for the New York market by factories at Concarneau and Douarnenez. Their preparation requires special care, and they command a high price. Sardines in oil are sometimes mixed with truffles. They are also prepared with tomatoes, and sent in small quantities to the New York market, but the chief export in this form is to Mexico. Sardines are also preserved in butter and in vinegar.

GARNETS IN BOHEMIA.

The United States Consul at Prague, in a recent report upon the garnet industry of Bohemia, says that although garnets are found in many countries, none compare in colour or brilliancy with the rich red stones of Bohemia. The celebrated baths of Bohemia were no doubt largely influential in creating an export trade in this article. Visitors to Carlsbad, Franzensbad, and Marienbad were attracted by the beautiful display of jewellery exhibited, and the

souvenirs carried back, caused a demand which has increased until garnets form no inconsiderable article of export. At the present time there are in the Bohemian garnet industry about 3,000 cutters and nearly 100 borers, employed in about 500 shops. Then there are professional garnet hunters, middlemen, merchants, &c., altogether, perhaps, 9,c00 to 10,000 persons in Bohemia earning their livelihood from this industry. Garnets are found mostly in the Bohemian Mittelgebirge, especially near Lobositz, Trebanitz, Triblitz, Laskonitz, Chrastow, and Nelluk. Mining for garnets is very simple. The earth is removed until the stratum containing the garnets is reached Unless this stratum is very rich, the excavation is not deep, and a shaft and galleries aie seldom required. The earth is then washed, and the stones sorted through a sieve. The cutting is done in Prague, Revensko, Semil, Sobatka, and Lomnitz, though the principal place is Turnan, near Reichenberg, where there is also a technical school for gem cutting and goldsmiths' work. Boys who have graduated from the *Bürgerschule* are admitted to this technical school, and certain pupils devote themselves to engraving, while others are taught the goldsmiths' art. Working after the best models of classical designs, very chaste and beautiful work is turned out in cutting, engraving, and setting. Garnet cutting differs little from the cutting of other precious stones. An expert places the raw stone upon a leaden anvil, and with a leaden hammer removes all superfluous or faulty parts, breaking the stone always in the direction of its cleavage. The stone then passes to the cutter. The machinery used by the cutter is very simple. A horizontal disc of lead, smeared with emery paste, which revolves upon a table, is turned by a hand-wheel. The garnet is held upon the disc until a flat surface is produced. This flat surface is then fastened with cement to the *kittstock*—a piece of wood shaped like a thin cigar. An apprentice now takes the stone and, by means of the revolving disc, shapes it or rounds it. It is now ready to have the facets cut. In order to produce facets of equal size, shape, and angle, a so-called quadrant is used. This quadrant holds the *kittstock* on the revolving disc at any desired angle, and admits of its being turned so that several facets may be cut. After the top of the stone is cut, the cement is softened over a lamp, the stone reversed, and the cutting completed. The gem then passes to the polisher, who treats it in a similar manner on a disc made of copper, tin, or bronze, smeared with a paste made of rotten stone instead of emery. Round or half-round smooth stones are polished on wooden discs, and are the work of specially skilful hands. They are generally used for the centres of larger pieces of jewellery. Garnets are sorted with sieves, and are sold by the *loth*, or $16\frac{2}{3}$ grammes. They are classified as *sechszehner*, *zweiunddreissiger*, *achtziger*, *hunderter*, &c., signifying that it takes 16, 32, 80, or 100 to make a *loth*. A large Bohemian garnet is a rarity, and very expensive. Large stones are found in great numbers in the Tyrol, but they are inferior in fire and hardness. In fire they become black, and do not recover their colour when cooled, as the Bohemian garnet does. There are various shades of garnets—violet, yellow, blue, green, and even black. The last, called melanite, is used for mourning jewellery. The green, or gooseberry stones, are prized more for their rarity than for their appearance. The finest garnet is always the deep red, sparkling, Bohemian stone. Up to the end of the last century, the Bohemian goldsmith knew of but one way to set garnets. Upon a metal base were soldered narrow strips of serrated metal; the teeth were then bent over to hold the gem in place. From Oriental and Italian jewellery the Bohemians learned the Pavé method, in which a hole is bored for each stone. About 40 years ago a Prague jeweller soldered to the metal base little pins, between which he fastened the gems. This proved not only to be durable, but allowed the utmost variation of form, so that the invention may be considered the foundation of the present industry.

General Notes.

PROTECTIVE SPECTACLES.—The Association des Industriels de France contre les Accidents du Travail opened a public competition for obtaining a good type of protecting spectacles, which should be accepted by those engaged in various industries where there is danger of injury to the eyes. The special committee appointed to award the prizes divided the spectacles sent in for competition into the following four classes:—(1) Those of glass surrounded by leather, which has the disadvantage of heating the eyes while excluding the air, and should only be used as a preservation from irritating vapours or dust; (2) those with glass and metal gratings, which also heat the eyes, and are inconvenient; (3) spectacles composed entirely of wire gauze, of finer or coarser mesh, which has the disadvantage of troubling the sight, and should be reserved for cases where large particles are projected, as in stone breaking; (4) the last class appears to have been represented by only a single specimen, that sent by M. Simmelbauer, of Montigny, near Metz, which was awarded the first prize. It is made with trapezoidal glasses, surrounded by wire gauze, does not heat the eyes, and was found by several workmen to be convenient, this type being specially serviceable in chemical laboratories, where tubes are liable to burst, and drops of a corrosive liquid to be thrown forward. The second prize was awarded to the Société des Lunettiers, for a pair of spectacles which permit long or short-sighted subjects to wear suitable glasses under the protective spectacles.

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FRIDAY, SEPTEMBER 1, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

BRITISH JUDGES.

The following is a revised list of the Judges for Agriculture, Live Stock, and Liberal Arts (see complete list of Judges, *ante*, p. 841):—

AGRICULTURE.

Food.—R. Bannister.
Adam Brown (Jamaica).
J. J. Quelch (British Guiana).
F. Shutt (Canada).
H. Vincent (Trinidad).

LIVE STOCK.

Rev. F. Vidal, James Weir.

LIBERAL ARTS.

Education.—Dr. O'Reilly.
Instruments of Precision.—Prof. John Milne, F.R.S.
Civil Engineering.—Urban H. Broughton.
Scientific Apparatus.—Prof. Silvanus P. Thompson, D.Sc., F.R.S.
Sanitation.—George Shaw.
Surgery and Medicine.—Ernest Hart.

AUDITOR'S REPORT.

The following report, issued by the Auditor of the Exhibition, shows the expenditure on the Exhibition up to July 31, and its financial position at that date. It will be seen that a total amount of 24,000,000 dollars, say nearly £5,000,000, had been expended, or liability for it incurred, £1,000,000 of this total being still owing. The receipts from admissions, concessions, &c., during the first three months amounted in round figures to 5,000,000 dollars. It is certain that the receipts for the last three months will largely exceed this sum. It is, therefore, evident that the liabilities of the Exposition Company will be met, for this amount would leave a balance over running expenses more than sufficient to meet actual liabilities. The amount that will be refunded to the Debenture bondholders must depend on the receipts of August, September, and October, and on the surplus that may remain from this source after the payment of charges incidental to the closing of the Fair.

The following is given as a condensed balance-sheet:—

Construction expenditures		\$17,134,869.15
Obligations under contracts		824,025.81
Obligations in suspense		860,303.07
Total		\$18,819,198.03
General and operating expenses		4,957,879.80
Preliminary organisation		90,674.97
Total		\$23,867,752.80
Capital stock		\$5,591,114.00
City of Chicago		5,000,000.00
Souvenir coins, and premium on same		2,429,580.78
Debenture bonds		4,444,500.00
Gate receipts		3,447,037.51
Interest		95,568.47
Concession receipts		1,178,546.92
Miscellaneous receipts		490,942.80
Obligations—		
Under contracts	\$824,025.81	
Accounts payable	401,258.08	
Pay rolls, last half July	195,616.65	
Salary rolls, last half July	30,000.05	
Vouchers not audited	197,000.00	
Purchasing agent's bills	50,000.00	
Construction department, unadjusted	71,806.37	
Water and sewerage department	65,880.00	
Live stock premiums	150,000.00	
Stock stables	100,000.00	
	\$2,085,586.96	
Less assets	895,124.64	
Net Liabilities		\$1,190,462.32
Total		\$23,867,752.80

Proceedings of the Society.

CANTOR LECTURES.

THE PRACTICAL MEASUREMENT OF ALTERNATING ELECTRIC CURRENTS.

BY PROF. J. A. FLEMING, M.A., D.Sc., F.R.S.

Lecture IV.—Delivered February 20, 1893.

MEASUREMENT OF ALTERNATING CURRENT ENERGY.

In this fourth and last lecture I propose to discuss the practical measurement of alternat-

ing current energy and alternating current quantity. In so doing we shall begin by dealing with the easier problem in the measurement of such quantities, viz., when the circuits to which the power or current is being supplied are non-inductive, and then proceed to consider the more difficult case in which the circuits are inductive circuits such as the primary circuits proceeding out from alternating current stations.

Instruments for the measurement of alternating current energy or quantity are called simply meters, and they are classified into ampère-hour meters and watt-hour meters. A complete classification of all the different forms of meter already invented would be a rather difficult thing to make on a perfectly correct basis. I shall give you presently an approximate classification. In the first case we will consider the simplest forms of meter, which may be called graphic ammeters and wattmeters.

Of these two the Holden ammeter and Mengarini wattmeter are good examples. In these instruments an arm carrying a pen is displaced over a paper-covered drum, which is revolved uniformly in 24 hours by a clock. The motion by which the pen is displaced is regulated by a part of the instrument which is simply an ammeter or a wattmeter, and the displacement of the pen is proportional to the current or the power passing through this measuring part. When, therefore, the diagram is cut off and unrolled, we find on the paper a curve which represents, by its ordinates, either the power or the current at any instant; and, if the whole area of the curve is integrated, then such area represents the whole energy or quantity which has passed through the meter in 24 hours. These instruments have the advantage, therefore, that we practically record two quantities at once; and they serve two purposes, of indicating the instantaneous current or power, and the total current quantity or energy, but they have the disadvantage that they are not self-integrating.

Next in order of simplicity are the self-integrating ammeter and self-integrating wattmeters. One of the simplest of these self-integrating ammeters, but which is, however, available only for the measurement of alternating current quantity, is the well-known Shallenberger meter.

Before me on the table are a series of meters, lent by different firms, and these I will put in motion, in order that you may see the movement.

The principle of the Shallenberger meter is not a difficult one to understand. It consists (see Fig. 1) of a small transformer, one coil of which we may call the primary, and which is in series with the circuit in which the current to be measured is flowing. The core of this transformer consists of a little soft iron disc, which is capable of revolving on an axis. This axis is geared at the top with a counting mechanism, which records the number of revolutions of the disc, and at the bottom there is a vane or fan of thin aluminium, which serves to retard the rotation of the disc.

The secondary circuit of this transformer consists of a small coil of copper, which is closed upon itself, and which is placed with its axis inclined at 45° to the axis of the primary coil. When the primary current flows through the primary coil it does two things—it magnetises the core, and it induces a secondary current in the closed secondary circuit. It is not difficult to show that the phase of this secondary current must be about 90° behind the phase of the primary current, and also that the magnetism of the iron core, which is in a direction at right angles of the plane of the primary coils, also lags in phase behind the primary current by about 90°. The magnetism of the core and the induced secondary current are, therefore, in step, and are in such directions that the axis of the disc is always being pulled round by the induced field of the secondary coil. If, then, there were no friction of any kind, the iron disc would be continually accelerated in speed, but since the air friction varies approximately as the square of the velocity, and since the mean driving force is proportional to the mean square of the current strength, it follows that the total number of revolutions which the disc makes in any given time is proportional to the total mean quantity or ampère hours which have passed the primary circuit. The meters can therefore be calibrated by a constant in such a way that they read directly ampère hours, and if the pressure between the mains is kept constant, they may be graduated to read in Board of Trade units.

These meters are very simple to construct and very fairly accurate in performance, and they have, therefore, come into extensive use. The velocity of the disc being at any time proportional to the mean current passing through the meter, we can, if the current is kept tolerably constant, employ the instrument as an ammeter. By moving the position of the secondary coil a little adjustment can be

made in the meter for change of frequency, and the meter can be calibrated for the particular frequency for which it is intended to be used.

Taking the particular meter before me, which is a 10-ampère meter, it starts with less than half an ampère and reads up to 10 ampères. The greatest variation within this limit in accuracy of reading is about 3 per cent. The meter has, therefore, a range of about 1 to 25, and, with care in adjustment, can be made to read more accurately than the above-mentioned figure.

The next meter in order of simplicity, and

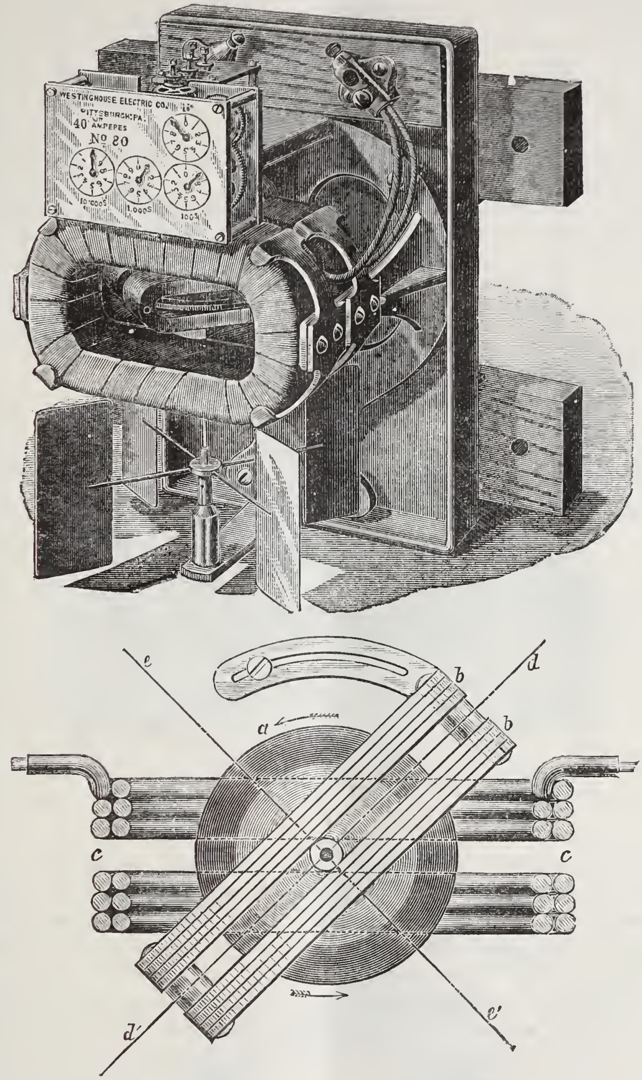

FIG. 1.—SHALLENBERGER METER.

very similar in principle to the Shallenberger, is the Wright-Ferranti meter. It is also a self-integrating ammeter; it measures at any instant the mean square current, and gives us the mean quantity which is passed through the meter. Looking at the diagram (Fig. 2) we see that the indicating part of the meter consists of a wheel with a light iron rim. This wheel is nearly embraced by two curved horns of laminated iron. These horns spring from the corners of a rectangle of laminated iron. This laminated iron rectangle is wound over on all four sides with two coils of wire. Through one of these coils the current to be

measured passes, and the other coil is a shunt coil, the function of which I shall describe presently. The arrangements of the coil are such that any moment the ends of the curved horns are opposite magnetic poles. On these curved horns are placed copper rings. When the alternating current passes through the series coil it creates alternating magnetism

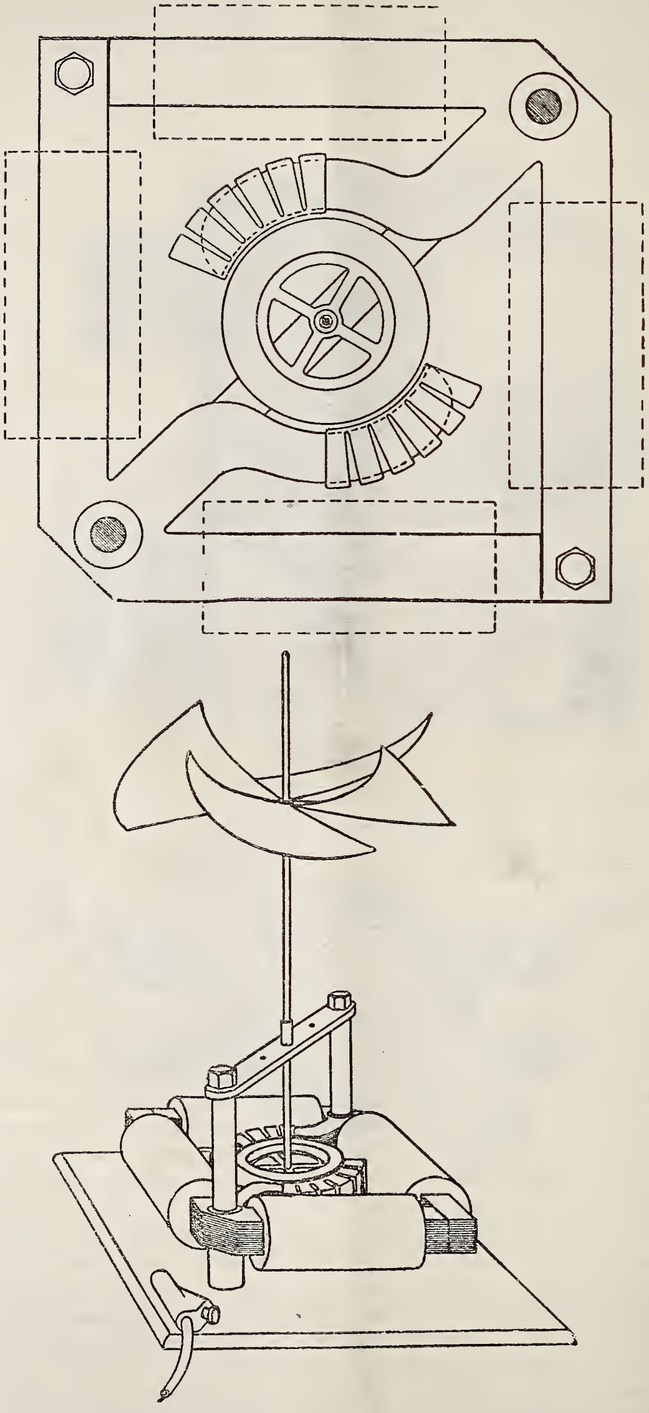

FIG. 2.—PLAN AND GENERAL VIEW OF WRIGHT-FERRANTI SELF-STARTING ALTERNATING MOTOR WORKING A FAN.

in these curved horns, but owing to the eddy currents of the set up in these embracing rings, the magnetic lines of force are thrust outwards, making a lateral leakage field, which travels up the horn. This leakage field induces eddy currents in the iron disc, and the disc is thereby repealed in virtue of the electro-magnetic repulsion set up between the horn and the wheel. An experiment to illustrate this repulsion can easily be shown.

In front of me is a large alternating current magnet. Across the top of this magnet I place a laminated iron bar. The laminated iron bar is embraced at intervals with copper rings. If I set the alternating current magnet in action, and if I hold the soft iron disc mounted on a pivot near to the laminated bar, it begins to revolve rapidly. We may explain this in another way, by saying that there are a series of alternating magnetic poles running up the iron bar, and that these alternating current poles produce other induced poles in the iron, and so drag the disc round. All these effects of electro-magnetic repulsion were more fully explained by me in a lecture once given in this place.

Returning, then, to the Wright-Ferranti meter, you will note that the axis which carries the wheel has upon it four aluminium or mica vanes, and also is connected at the top to a counting mechanism. When an alternating current is passed through the meter it tends to drive the wheel round with a speed which is proportional to the mean-square strength of the current, and, therefore, it follows that the number of revolutions made

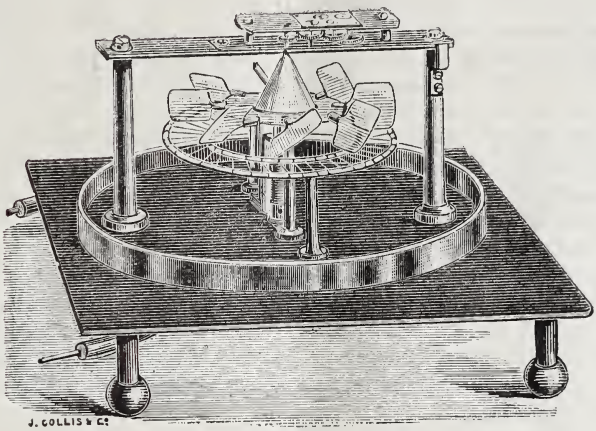

Fig. 3.—Forbes Meter.

by the wheel at a given time is proportional to the mean quantity in ammeter hours which has passed through the meter at that time.

The meter before me is a 20-ampère meter, which starts with a current of about half an ampère, and reads up to 20 ampères. Within these limits the greatest deviation in accuracy is only about 1·8 per cent. Both the Shallenberger meter and the Wright-Ferranti meter require to be calibrated for the particular frequency for which they are to be used, and they only give Board of Trade units provided that the pressure is kept constant between the supply mains. The meter really reads quantity directly, and power only on the assumption of the constancy of pressure.

I mentioned, a moment ago, that there were two circuits on the electro-magnet, and that one of these was the shunt circuit. The function of this shunt circuit is to supply the driving force which overcomes the friction of the counting train. If this shunt circuit were not present, there would be a frictional resistance to be overcome before the meter would start at all.

Another meter, of a tolerably simple character, also intended for measuring ampère hours, is the windmill meter, invented by Professor Forbes some years ago. In that meter (Fig. 3) there is a coil of wire, which was heated by the current passing through it. This heated coil generates an upward current of air, and this upward current of air is made to turn round a very delicately constructed wind-

mill with mica vanes. The counting train attached to the windmill records the number of turns in a given time. Although this may seem to have been a somewhat unpromising principle to apply, yet the meter in itself gave excellent results.

We turn next to the consideration of the second great class of meters, namely, the watt-hour meters, which are self-integrating. These self-integrating watt-hour meters may also be divided into two classes, continuously and intermittently integrating.

Taking the last class first, this is well represented by the Frager meter. In this meter there are two distinct parts, first, the wattmeter part, which measures at any instant the power, and the integrating part, which integrates at intervals the power and the time. The wattmeter part, as you will see, on looking at the instrument, consists of a wattmeter having a thick coil, which is a series coil, and a movable coil, which is suspended by a steel wire which is a-shunt across the circuit. The terminals of the shunt coil are connected to the two sides of the mains, and the current to be measured is passed through the series coil. Attached to the movable shunt coil is a long arm, and the displacement of this arm varies with the power passing through the instrument. Adjacent to the wattmeter and fixed on the same base is an electrical clock, which drives round a curved plate of metal, which is technically termed "the snail." On the end of the long projecting arm attached to the wattmeter is a small steel point. As the snail is turned round it passes underneath this arm, and if this arm is displaced, the length of the path of the pointer, when travelling over the snail, is proportional to the power passing through the wattmeter. The snail plate is so suspended that when the pointer passes over it it presses it down, and makes an engagement between the snail and the counting mechanism. At each revolution of the snail the counting mechanism is turned round by a number of revolutions which are proportional to the mean power or watts passing, and hence the total number of revolutions in any given time is proportional to the watt-hours which have passed through the meter. The snail revolves round in a period which is about three minutes, and hence the record is, as it were, made of the power passing through the wattmeter only at intervals of three minutes. If the current which is to be measured does not vary very rapidly, such an intermittent recording meter may be made to give very accurate results, but there are many cases, such as in theatres, where the amount of current passing through the meter is very irregular and rapidly varied. Under these conditions the wattmeter needle is thrown about in such a manner that the actual power recorded on the dials at every revolution is not always the true mean power passing in the interval between two revolutions, and the readings of the meter may, therefore, become very erroneous. Practice has confirmed these inferences, and although the Frager meter is under some conditions of use a very accurate meter, there are other conditions under which its readings are not to be depended on.

Coming next to the continuously recording watt-hour meters, we reach that class of meter which may be said to be the best adapted for general wants, and one of the most efficient of these continuously recording watt-hour meters is the one invented by Professor Elihu Thomson. The Thomson recording wattmeter is, as you will see from the specimens before us, a wattmeter in which one coil, called a series coil, carries the current to be measured. These series coils really form the field magnet of a very small electro-motor. The armature of this motor is a beautiful one, having a small commutator and brushes of the usual kind, and this armature circuit, together with the external added resistance, constitutes the shunt circuit of the wattmeter. When the meter is attached to a circuit, the main current of which passes through the series coils, and the shunt coil being attached to the two mains, the armature begins to revolve. The shaft which carries the armature carries also a copper disc, which is embraced by three horseshoe magnets. When the disc revolves, eddy currents are set up in the disc which retard its motion. The number of revolutions of the disc in a given time is recorded by the counting mechanism attached to the shaft. Then since the force driving the armature round is at any instant proportional to the power passing through the instrument, and since the retarding force is proportional to the velocity, if follows that the number of revolutions in a given time represents the watt-hours that have passed through the meter. In order to overcome the constant friction of the train, there is a compound winding on the field magnet, consisting of a few turns of the shunt coil, which is arranged in such a direction that the driving force due to the fixed and movable shunt-winding, tends to overcome the permanent friction of the armature shaft.

By properly treating the permanent magnets, it is found that they retain a constant magnetism for long periods of time. The meter is so arranged that, when working on a 100 volt circuit, the shunt coil has a resistance of 1,000 ohms altogether, and takes, therefore, ·1 of an ampère. The loss in the meter, therefore, is only 10 watts, which is the power taken up in driving the meter. By properly arranging the shunt coil, it is possible to make the constant of this meter perfectly constant for a very large range of its action, and one great advantage which this meter has is that it can be employed with both alternating and continuous currents. When properly adjusted, this watt hour meter is capable of very great accuracy in the measurement of alternating current energy.

There are several other meters, which time will hardly permit me to describe fully, but a brief allusion may be made to them.

One meter before me is called the Brillié meter, and is of the type of the Frager meter; that is to say, it is an intermittent recording wattmeter. Another meter, of which I spoke at the beginning of the lecture, namely, the Mengarini recording wattmeter, is also before me. This last meter has been extensively employed on the alternating current circuits of the Rome Electric Lighting Station.

Reviewing, then, the whole of these meters, we may say that a rough classification of meters for the measurement of alternating currents may be made as follows:—

1. Graphic recording ammeters.
2. Graphic recording wattmeters.
3. Continuously recording ampère - hour meters.
4. Intermittent recording wattmeters.
5. Continuously recording wattmeters.

We may ask ourselves at this stage what ought to be the characteristics and requirements in a good commercial meter for the measurement of electric energy supply to houses, for lighting and other purposes. Most persons without experience would probably say that the first requirement in a meter is accuracy; but as a practical matter accuracy is not of so much importance as that the meter should never go far wrong. A type of meter which is capable of measuring, under some conditions, to ·1 of accuracy, and at other times is liable to make errors of 150 per cent. in actual practice, is not nearly so useful as a meter which will not read closer than 1 per cent., and yet which, in actual practice, never proves to go more than 3 per cent. wrong.

The next condition which a meter must comply with is that of the consumption of small power. Since the meter is connected to the circuit continually, if it absorbs power, the sum total of all these consumptions may amount to a serious item. We have pointed out, in speaking of voltmeters, that a continuous power absorption, say of 20 watts, during the whole year, amounts to a yearly consumption of 160 units of electric energy, and that, therefore, small power consumption is certainly an important item in appraising a meter.

The third great requisite is, that the meter ought not to require elaborate care and delicacy in fixing, and that it ought to be hardy enough to be easy of carriage. House meters have to be fixed in places which are sometimes subject to vibration and dampness, &c., and a meter for house purposes ought, therefore, to be hardy enough to stand these conditions.

The fourth condition is, that the meter must be so constructed in principle as not to be capable of being easily tampered with, or its indications made to vary, even when enclosed in a lock-up case.

To the above requirements ought, of course, to be added the broad and general conditions of simplicity of structure and cheapness in price, as far as consistent with good workmanship.

I now turn to the important subject of the measurement of alternating current power, when supplied to inductive circuits; in other words, we have to study alternating current primary meters. In the distribution of alternating currents for commercial purposes, not only is it necessary to be able to measure the power or energy supplied to the consumer on the lamp circuits, but it is also necessary to be able to measure the power and energy sent out from the alternating current station which is supplying, generally, transformer circuits. Hence, we have to consider the special difficulties of making such measurements on circuits, which have a considerable self-induction, or in which the power-factor of the circuits is below unity.

During the past year or two, I have paid particular attention to this subject, in a long series of researches on the efficiency of transformers, and have thereby been led to study most of the various methods which have, from time to time, been proposed for measuring alternating current energy.

I do not propose to occupy the time—already brief—in discussing any of the methods which, however well they look on paper, are yet, for some reason or other, inapplicable in practice, but to describe the methods which have proved themselves, in my experience, satisfactory and practicable in making these measurements. I have found that the two instruments for this purpose which are capable of being employed with very satisfactory results for the measurement of alternating current energy on inductive circuits are the Thomson recording wattmeter and the Mengarini wattmeter already described.

Generally speaking, these measurements have to be made on high-tension circuits. Take, for instance, the very common case of an alternating current station, supplying alternating current at a pressure of 2,000 volts on transformer circuits. One method of employing either of the above wattmeters as energy meters would be to place a non-inductive resistance of sufficient magnitude in series with a shunt coil, and to put the series coil in the series with one of the primary mains.

In such an arrangement there would be certain disadvantages. In the first place, the Thomson recording wattmeter takes a current of about 1-10th of an ampère through the shunt, and hence we should have to add to the shunt coil, the resistance of which is about 1,000 ohms, another 19,000 ohms, of non-inductive resistance, and then when this was done the power wasted in the whole of these shunt circuits would be 200 watts. If these shunt circuits were kept connected to the mains throughout the whole year, the waste of energy in these shunt circuits would be something like 1,600 Board of Trade units, and if we reckon the manufacturing cost of these at only 2d. a unit, it would cost something like £12 per annum merely to supply the shunt circuit with current. But this difficulty can be got over, and also the difficulty of constructing a large non-inductive resistance of 20,000 ohms, sufficiently well divided up not to be in any danger of breaking down with 2,000 volts pressure, by the adoption of a transformer to excite the shunt circuits in the way described in my last lecture. A small transformer is employed, transforming down from 2,000 volts to 100 volts, and as this transformer is only to supply 1-10th of an ampère on its secondary circuit, it can be made very small, not more than, say, a tenth of horse-power in capacity. It can, therefore, be made to waste not more than about 10 to 20 watts in itself. This transformer has its primary circuits connected across the primary mains, and its secondary circuit is connected across the terminals of the shunt circuit of the Thomson wattmeter, and so joined up that the current in the shunt circuit of the wattmeter is in the same direction and has the same magnitude as if the wattmeter were joined up simply on a 100 volt circuit in the ordinary way.

The wattmeter in itself only wastes about 10 watts in its shunt circuit, and, therefore, the whole arrangement of the transformer and wattmeter can be made to waste not more than, say 25 to 30 watts, instead of 200, and reduce the cost of up-keep to something like 200 units a year instead of 1,600. The primary current going out of the station is then taken through the series coil of the Thomson wattmeter, and in order to keep all the parts of the wattmeter at the same potential, one terminal of the secondary circuit and the little transformer, is also joined up to the primary main on the side nearest to it.

It is usual to mount the transformer and wattmeter on one board, and then to insulate the whole of this board well. The first step is to calibrate the wattmeter. This can be done most easily on a 100 volt circuit by passing through the meter known powers, and observing the reading of the dials. The constant of the meter then has to be multiplied by the transformation ratio of the small transformer, in order to obtain what may be called the high tension constant of the meter. When this is done, the meter can be set up in the station in such a way that the whole current going out of the station passes through the meter, and the engineer can, by taking observations from day to day, record the whole number of units which have been sent out from the generating station on the primary circuits in any interval of time. In exactly the same manner I have found it possible to employ a Mengarini wattmeter coupled with a transformer and placed on the primary circuit. This has the advantage that it not only enables us to record the whole of the energy going out of the station in a given time, but to know at any instant the primary watts.

Before placing confidence in either of these two methods, I made a very careful series of observations on an inductive alternating current primary circuit, in which I employed the Thomson self-integrating wattmeter as above described, to measure the whole number of units sent out along that primary circuit in four hours, and at the same time observations were made on the same circuit by means of a

wattmeter to obtain the power sent out at intervals of minutes. When these observations were compared and reduced, it was found that the power sent out in four hours, as determined by the observations, was 66·924 units in the wattmeter, and the energy given by the self-integrating Thomson wattmeter in the same time was 66·946. It thus became evident that the Thomson recording wattmeter was capable of giving very accurate results as a primary wattmeter, and that there is no reason whatever why the record of the primary energy sent out should not be made in alternating current stations with the same accuracy as in the case of continuous current stations.

To complete arrangements it would be desirable, in the case of an alternating current station, in order to enable the engineer to know exactly what the result of his working is, to act as follows :—

On the primary should be placed, in the first place, an ammeter, capable of measuring alternating currents and giving the mean-square value. In the second place, an electrostatic high tension volt meter should be connected across the mains in order to give the high tension volts. In front of this instrument should be placed a Mengarini wattmeter and a Thomson self-recording wattmeter, the whole primary current from the station going through the series coils of these instruments. The shunt circuits of these instruments should be excited by a small transformer, transforming down from a working pressure of 100 to 50 volts. These instruments would then enable the engineer, by daily readings, to record, first, the energy sent out of the primary circuits in Board of Trade units in any time ; secondly, the power being sent out at any instant measured in watts; thirdly, the primary current being sent out at any instant, and the primary pressure, and, therefore, from the product of these two, the apparent power being sent out at any instant; and, fourthly, from the readings of the real and apparent power, the power factor of the station could be ascertained at any instant.

By comparing these readings with the sum total of the house meters taken at any intervals, the engineer would be enabled to know the efficiency of distribution of his alternating current station, and to reckon out, not only the cost of the unit sold, but the cost of the unit generated, and to watch and know the effect of any improvements that are made in the transformers on the system.

It is only by adopting such methods of measurement that engineers in charge of alternating current stations will be able to remove the reproach which is sometimes hurled at them, that they have no means of measuring the energy or power they are supplying, or of knowing how much of what they make is sold.

In concluding this course of lectures, I have to thank all those firms and gentlemen who have lent me the numerous instruments which I have been able to exhibit to you here. My endeavour has been to put the subject before you in as practical a manner as possible, and to give you, as it were, the cream of practical experience, rather than the skim milk of mere theory. It would have been difficult to do this without the practical exhibition of instruments of various types, and I do not think that any single instrument of practical importance has been mentioned, an example of which has not been placed before you. The practical measurement of alternating currents may be more difficult, in many respects, than the measurement of continuous currents, but, at any rate, we have the satisfaction of knowing that it is now placed on an equally certain and satisfactory basis.

Miscellaneous.

THE IMPERIAL CUSTOMS.

The thirty-seventh annual report of the Commissioners of her Majesty's Customs shows that the gross receipt of the revenue for the financial year ended March 31, 1893, amounted to £19,885,339, including warehousing charges and £74,956 for the Isle of Man, as compared with £20,092,787 in the previous twelve months. The only alteration in the tariff was in connection with sparkling wine, a fixed additional duty of 2s. per gallon being substituted for the former rate of 1s. per gallon for wine not exceeding 15s. per gallon in market value, and 2s. 6d. per gallon for all wine in excess of that value. With the above exception, there was no legislation in the year 1892 affecting Customs administration. Foreign chicory exhibited a decrease of £622, or about 1 per cent.; coffee a decrease of £3,860, or about 2·1 per cent.; cocoa and chocolate a decrease of £3,067, or 2·8 per cent.; currants a decrease of £13,963, or 12·2 per cent.; raisins an increase of £16,145, or 9·2 per cent.; figs, plums, and prunes a decrease of £3,626, or nearly 6·3 per

cent.; foreign spirits a decrease of £352,808, or 7·6 per cent.; and rum a decrease of £256,612. It is pointed out that the taste for rum has diminished greatly since 1875, when its consumption reached its highest point. In that year 5,386,000 gallons were taken for home consumption, when the population numbered 32,749,000; in 1892, 4,268,000 gallons represented the demand of a population of 38,109,000 persons—a decline of 20 per cent. in the consumption against an increase of 16 per cent. in the population. The impetus given to the rum trade in the years 1889 and 1890 has not, however, yet died away, the quantity consumed in 1892 exceeding that consumed in 1888 by 407,000 gallons. The net Imperial revenue from brandy was £1,334,221, against £1,423,836 in 1891-92, a fall of £89,615. This heavy fall has neutralised the substantial advances of £77,783, made in 1891-92, and £14,784 made in 1890-91, and has reduced the yield to a sum very closely approximating to that of the year 1889-90, which was £1,331,269. This result, as also in the case of rum is, according to the Commissioners, probably attributable to the less satisfactory condition of trade. The net yield of Geneva and other sorts of foreign spirits was £678,768, an increase of £9,847 over the produce of last year. This increase is declared to be satisfactory, as showing that the effects of the famine in the East of Europe are beginning to pass away. The result has been to cause a fall in the price of foreign plain spirit in this country, and thus to increase the demand for it. The gross yield from tea was £3,406,225, being a decrease of £18,605, or just over ½ per cent. "Tea," say the Commissioners, "is an article so widely used among all classes of the community, and has made such steady progress for so many years in popular estimation, that the present apparent check seems almost a matter of surprise; but, probably, it may be attributed to the effect of the general slackness of trade, and to expectation by some merchants that the tea duty would be lowered. They were thus led to withhold payment towards the end of the financial year, until the publication of the budget. The displacement of China tea by tea of East India growth continues, the use of the latter having risen in 1892 by 22,468,000 lbs., while that of Chinese and Javanese origin has fallen by 17,840,000 lbs. The use of Ceylon tea alone increased by 12,000,000 lbs. in that year." Tobacco yielded £171,095 more than in 1892, while in regard to wine there was a decrease of 1·7 per cent. With reference to smuggling, the quantities of goods seized, the number of persons convicted, and the amount of the penalties recovered, while showing some increase over the figures of last year, have been exceeded in some previous years. The number of convictions, and the number and the amount of penalties recovered, would be greater but for the frequency of cases in which tobacco for which no owner can be found has been discovered concealed on board vessels. These cases increase the record of the number of seizures, but do not add to the number of persons convicted, or to the amount of penalties recovered. There have, however, been several seizures of dutiable goods in considerable quantities. The number of detentions under the Merchandise Marks Acts has increased during the past year, having risen from 3,321 in 1891-92, to 3,880 in 1892-93, exclusive of the Parcel Post. Of these detentions 436 were ultimately retained as seizures. In the Parcel Post the number of detentions has decreased by 142, having fallen from 1,283 in 1891-92 to 1,141 in 1892-93. Of these detentions 97 were ultimately detained as seizures. The Commissioners observe:—"It is somewhat unsatisfactory to record an increase in the number of detentions. It might have been hoped that after the Act of 1887 had been some years in operation its provisions would have been observed with increasing strictness. Such, however, has not proved to be the case, and, although many omissions to mark goods satisfactorily, may be set down to carelessness on the part of those in this country ordering foreign goods as well as on the part ot the foreign vendors, it will be a matter for consideration whether we shall not have to impose heavier penalties in order to secure a due compliance with the requirements of the law." The outbreak of cholera upon the Continent of Europe towards the end of the summer of 1892, and its continuance during practically the remainder of the year, imposed an appreciable amount of special care and responsibility on Customs' officers, to whom the duties of enquiry and action under the Quarantine and Public Health Acts, as far as incoming ships are concerned, are primarily entrusted, and the Commissioners directed special vigilance to be exercised in respect of vessels coming from cholera-infected or suspected ports. There was an obvious risk that cholera might be introduced in the large quantity of rags brought from abroad for the purpose of remanufacture into paper; and, in view of this fact, the Local Government Board temporarily prohibited the importation into England and Wales of rags from France, the Black Sea ports, and ports in Turkey-in-Asia; and, subsequently—on account of the spread of the disease—of rags, dirty bedding, and disused or filthy clothing from any European port, north of Dunkirk, other than from Scandinavia or Dunkirk. The Local Government Board in Ireland, and the Board of Supervision in Scotland, respectively, concurred in all these and subsequent provisions, which thus became practically uniform for the United Kingdom. The Customs' officers also assisted in the execution of the instructions prohibiting the landing of alien immigrants in a "filthy or otherwise unwholesome condition;" and the Commissioners understand that the steamship companies, fearing that such persons could not be landed here, and that they would have to feed them—perhaps for a long time—on board their vessels, or even ultimately reconvey them to their ports of departure, instructed heir agents on the Continent to exercise c reful scrutiny before booking passages.

CALCUTTA ROYAL BOTANIC GARDEN.

In his annual report on the Royal Botanic Garden, Calcutta, the Superintendent (Dr. G. King) mentions that the usual amount of attention was given to the cultivation and distribution of plants of economic interest. As many as possible of the plant producing sisal hemp (*Agave rigida*, var, *sisalana*) were distributed, having been obtained from America through the good offices of the Director of the Royal Garden, Kew. Considerable quantities of the large-leaved mahogany were issued for planting in avenues in cantonments and civil stations. Rheea plants were also issued as asked for. The interest in rheea cultivation, the Superintendent observes, is of a very flickering sort, and at present it has almost died out in the neighbourhood of Calcutta. Plants of the cola-nut tree (*Cola acuminata*) were given out as far as the limited stock permitted. All efforts to introduce the cultivation of the Japanese paper mulberry have failed. A small plantation is, however, kept up to meet any future demand. As the Japanese mulberry yields a most beautiful fibre, which is naturally so white that it requires very little bleaching, it seems a pity, Dr. King remarks, that no wealthy landowner has taken up its cultivation on a large scale. Work in the Herbarium went on as usual, botanical references having been answered and plants named for correspondents in increased numbers. Specimens to the number of 15,750 were received from various sources, while 8,787 specimens (all carefully named) were issued to various botanical institutions throughout the world. The plants thus distributed belonged largely to families of which either Dr. King or the Curator of the Herbarium (Dr. Prain) have recently made particular study. Foremost amongst the institutions to which the Herbarium is indebted for contributions during the year is the Royal Herbarium at Kew, the Director of which contributed 2,200 specimens. Next in numbers is the collection of Western Indian species received from Dr. T. Cooke, C.I.E., Principal of the College of Science, Poona. Dr. Cooke's contribution (which contained 1,559 specimens) is described as a peculiarly acceptable one, as heretofore the flora of Western India had been but poorly represented in Calcutta. Mr. C. B. Clarke, late of the Indian Educational Department, to whom the Herbarium is already deeply beholden, continued his generous contributions by sending, during the year, 606 specimens collected by himself, chiefly in the jungles of Manipur and Assam. Mr. Scott-Elliot, a gentleman who has travelled much in the interests of botany, sent, as a contribution from Egypt, 121 plants. The Directors of Herbaria in Europe contributed as follows:—Imperial Garden, Berlin, 849 specimens; Herbarium Imperial Botanic Garden, Vienna, 600 specimens; Imperial Garden, St. Petersburg, 218; Royal Garden, Leiden, 24; while from the University of Melbourne there were received 417 specimens. With reference to the botanical collection Dr. King writes:—"Through the direct agency of the officers attached to this garden the following were received — Mr. R. Pantling, orchids of Sikkim, 1,500; Mr. G. Gammie, from Independent Sikkim, 1,021; E. H. Man, Esq, C.I.E., Andamans collections, 867; Dr. Prain, from North Bengal, 68; native collectors, Botanical Survey of Burma, 1,064; native collectors, Botanical Survey of Assam, 852. The collections made by Mr. Gammie were the result of a botanical excursion to some of the less known parts of Independent Sikkim and of the Tibetan frontier, on which he was specially deputed with the sanction of Government. They contain many rare plants of much interest. Mr. Gammie was absent for four months. His first excursion extended through the Singalelah range to its origin in Kinchinjunga. In the vicinity of Kinchinjunga itself, Mr. Gammie was, on account of the great inclemency of the weather, able to remain only a few days. He next travelled across Sikkim to Tumloong, from whence he followed up the Tista to Chungtam. From thence Mr. Gammie explored the Lachung valley as far as the Donkia La, which was the northern limit of his travels. He spent two months in forming collections in this valley, and then ascended to Thanka La, and also to Ghora La, at the head of the Sebu valley, one of the few tracts in this region Sir Joseph Hooker was unable to visit during his sojourn in the Eastern Himalayas, in 1849-50. From Lachung Mr. Gammie returned to Tumloonga, and from thence he traversed the Chola range, visiting the Cho-la, Yak-la, and Zey-lap-la passes. He returned to the cinchona plantation by the military road from Gnatong to the Tista bridge. Mr. Pantling's collections consisted exclusively of orchids, of many of which he has prepared most admirable drawings, which, I trust, it may some day be possible to publish. The collections from the Andamans have been made by two Burmese, who have worked under the supervision of Mr. E. H. Man, C.I.E., whose efforts to help in the exploration of these islands have been most disinterested and laborious, and to whom this garden is very deeply indebted. Native collectors were sent, as usual to Assam and Burma, and they brought back fairly good collections of common plants."

ST. PETERSBURG FRUIT CULTURE EXHIBITION, 1894.

The Russian Society of Fruit Culture is organising, with the sanction of the Emperor, an international exhibition, to be held at St. Petersburg in the autumn of 1894, with the object of showing the present condition in Russia and other countries of the cultivation of fruit and vegetables, of viniculture, the cultivation of medicinal plants, horticulture, and of the manufacture of their products. A congress of pomologists will be convened in connection with the exhibition. The exhibition will comprise the following sections:—(1) Fresh fruit, (2) fresh vegetables,

(3) dried fruit and vegetables, preserved or treated by other processes; (4) wine, cider, perry, and other fruit beverages; (5) hops and medicinal herbs; (6) seeds; (7) fruit trees and bushes; (8) horticultural implements and appliances and "technicality of production"; (9) literary, scientific, and educational accessories, collections, plans, &c. All persons interested in the progress of horticulture and pomology, both in Russia and other countries, are invited to take part in this international exhibition. Further information can be obtained at the offices of the International Exhibition of Fruit Culture, 1894, at St. Petersburg, Imperial Agricultural Museum, Fontanka, 10.

CALIFORNIAN EXPOSITION, 1894.

An International Exposition will be held in the city of San Francisco, State of California, beginning on January 1, 1894, and continuing six months. Midwinter is chosen as the time for holding this fair because the climatic conditions of San Francisco and a large part of California make the months between December and July the pleasantest of the year. The range of the temperature during this season is from 55° to 70° Fahrenheit, the mercury rarely falling below the first-named point, and invariably attaining the latter on sunny days. Although the term "midwinter" is used, it is stated to be, in some sense, a misnomer, as January, February, and March are really spring months in the latitude of San Francisco, on the Pacific Coast. The rains, which begin to fall as early as November, promote vegetation, and before the new year sets in the hills and country surrounding the bay of San Francisco are covered with verdure. In January and February wild flowers are abundant throughout the State; and in April, when the farmers of other sections of the Union are getting ready to plant their crops, the Californian agriculturist is preparing to harvest his. It is during this season of the year that the orange crop of California is harvested. The groves of San Bernardino, Los Angelos, San Diego, and other counties are seen at their best in January, February, and March.

It is further claimed for San Francisco and California that they have other features which make them interesting to the tourist and pleasure seeker. The survivals of Spanish customs and the architecture of the Mission period are among these, and in San Francisco the remarkable Chinese colony, containing between thirty or forty thousand people, who have brought all their Oriental habits with them, is a source of curiosity.

San Francisco has a population of about 350,000 persons, and immediately opposite, on the shore of the bay, are placed Oakland and other cities, containing 100,000 more inhabitants, who reach the Pacific Coast metropolis by crossing a swift ferry. The State of California contains about 1,500,000 inhabitants, and the states and territories adjoining, all of whose people take a hearty interest in the Midwinter Fair, have nearly a million more people.

The general classification will be as follows:—

Department A.—Agriculture, food and its accessories, forestry and forest products, agricultural machinery and appliances; horticulture, viticulture, and pomology; fish, fisheries, products and apparatus of fishing.

Department B.—Machinery; mines, mining, and metallurgy; transportation—railway, vessels, vehicles; electricity and electrical appliances.

Department C.—Manufactures; liberal arts—education, literature, engineering, public works, constructive architecture, music and the drama; ethnology, archæology; progress of labour and invention.

Department D.—Fine arts: painting, sculpture, architecture, decoration.

Department E.—Isolated and collective exhibits.

Mr. M. H. de Young is the Director-General and President of the Executive Committee, and all applications for space, &c., must be made to him, addressed Director-General, California Midwinter International Exposition, San Francisco, California, U.S.A.

Obituary.

H. C. SAUNDERS, Q.C.—The Society has suffered a severe loss by the sudden death, at Painswick Vicarage, Stroud, on the 25th ult., of Mr. Herbert Clifford Saunders, Q.C. He joined the Society in 1872, and was elected a Member of the Council at the last annual meeting. He was greatly interested in the spread of technical education, and took the chair on the occasion of the reading of a paper, in 1887, on "The Uses, Objects, and Methods of Technical Education in Elementary Schools." He also presided at another of the Society's meetings in March of the present year, when Sir Philip Magnus dealt with the "Progress and Prospects of Technical Education." Mr. Saunders had, for some years past, ably filled the post of Chairman of the Executive Committee of the City and Guilds of London Institute, and was a Member of the Technical Education Board of the London County Council. He was the third son of the late Mr. Charles A. Saunders, was educated at Christ Church, Oxford, graduating B.A. in 1856, and proceeding M.A. in due course, was called to the Bar at the Middle Temple in 1859, received silk in 1881, and was elected a bencher of his Inn in 1884.

General Notes.

PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN.—The Congress of the Photographic Society of Great Britain, and Affiliated Societies, will be held on the 10th, 11th, and 12th of October, at the rooms of the Society of Arts. Programmes can be had on application by postcard to the Hon. Secretary of the Photographic Society, 50, Great Russell-street, Bloomsbury, W.C.

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FRIDAY, SEPTEMBER 8, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

EXAMINATIONS.

The programme of the Society's Examinations for 1894 is now ready, and can be obtained on application to the Secretary.

The dates fixed are March 12, 13, 14, and 15.

The arrangements of the time-table, the subjects, and the prizes offered correspond with those of the last examination.

Chicago Exhibition, 1893.

ATTENDANCES AT THE EXHIBITION

The official figures for the admissions to the World's Fair during the first week of August

are		551,146
and for the second week		667,274
August	15	123,530
,,	16	112,368
,,	17	141,394
,,	18	1-23,428
,,	19	168,861
,,	20	21,448
,,	21	129,619

August 19 was the British day, and the attendance was larger than on any previous day, except July 4.

AWARDS IN FINE ARTS DEPARTMENT.

Medals have been awarded to the following British exhibitors in the Fine Arts Department:—

Oil Paintings.

W. H. Bartlett; G. H. Boughton, A.R.A.; Frank Bramley; Frank Brangwyn; Frederick Brown; Lady Butler; W. Carter; George Clausen, R.A.; Frank Dicksee, R.A.; Alfred East, R.I.; H. Fisher; S. Melton Fisher; Morley Fletcher; Mrs. Stanhope Forbes; Stanhope R. Forbes, A.R.A.; T. F. Goodall; T. C. Gotch; A. C. Gow, R.A.; Peter Graham, R.A.; Arthur Hacker, R.A.; Hubert Herkomer, R.A.; J. C. Hook, R.A.; Colin Hunter, R.A.; G. W. Joy; Yeend King, R.I.; John Lavery; B. W. Leader, A.R.A.; Sir Frederick Leighton, Bart., P.R.I.; Sir James D. Linton, P.R.I.; W. Logsdail; Mouat Loudan; Seymour Lucas, A.R.A.; Robert W. Macbeth, A.R.A.; Mrs. Anna Lea Merritt; Sir John Millais, Bart., R.A.; Mrs. Clara Montalba; Albert Moore; Henry Moore, R.A.; P. R. Morris, A.R.A.; David Murray, A.R.A.; W. R. Orchardson, R.A.; Walter Osborne, R.H.A.; W. W. Ouless, R.A.; Alfred Parsons, R.I.; Ernest Parton; John R. Reid; Briton Riviere, R.A.; James Sant, R.A.; J. J. Shannon; Soloman J. Soloman; Mrs. Adrian Stokes; A. Stokes; Marcus Stone, R.A.; Edward Stott; William Stott; J. M. Swann; Mrs. Anne L. Synnerton; Mrs. Alma Tadema; Miss Anna Alma Tadema; L. Alma Tadema, R.A.; A. C. Tayler; H. H. La Thangue; Leslie Thomson; William H. Titcombe; H. S. Tuke; J. W. Waterhouse, A.R.A.; E. A. Waterlow; G. Wetherbee; Miss E. Stewart Wood; Henry Woods, A.R.A.; Charles W. Wyllie; W. L. Wyllie, A.R.A.

Water Colours.

Mrs. Allingham; H. Coutts; A. East, R.I.; Birket Foster, R.W.S.; Sir John Gilbert, R.A.; Andrew C. Gow, R.A.; W. Hatherell, R.I.; Edwin Hayes, R.H.A.; J. Hay Henshall, R.W.S.; Hyman George Hine, R.I.; Walter Langley, R.I.; Sir James D. Linton, P.R.I.; Tom Lloyd, R.W.S.; Henry Moore, R.A.; Alfred Parsons, A.R.A.; Henrietta Rae; W. Rainey; Leopold Rivers; Lionel P. Smythe; L. Alma Tadema, R.A.; E. A. Walton, A.R.S.A.; W. L. Wyllie, A.R.A.

Black and White.

John Charlton; Kate Greenaway; F. Seymour Haden, P.R.P.E.; Sir James D. Linton, P.R.I.; George du Maurier; W. H. Overend; John M. Swan, Sir John Tenniel; J. R. Weguelin.

Engravings, &c.

Etchings—D. D. Cameron; Herbert Dicksee; Oliver Hall, R.P.E.; William Hole, R.S.A.; David Law; Leopold Lowenstam; Miss Ethel Martyn; Robert W. Macbeth, A.R.A.; Mortimer Menpes, R.P.E.; Charles J. Watson. Line Engraving—Charles William Sherborn. Mezzotint — Gerald Robinson. Wood Engraving—W. Biscombe Gardner.

Sculpture.

Sir F. Leighton, Bart., P.R.A.; George Frampton; W. G. John; Hamo Thornycroft, R.A.; John M. Swan; F. W. Pomeroy; E. Onslow Ford, A.R.A.

Proceedings of the Society.

HOWARD LECTURES.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.

BY PROF. W. CAWTHORNE UNWIN, F.R.S.

Lecture I.—Delivered January 13, 1893.

THE CONDITIONS IN WHICH DISTRIBUTION OF ENERGY IS REQUIRED.—SOURCES OF ENERGY.—THE CONDITIONS OF ECONOMY AND WASTE IN PRODUCING STEAM-POWER.

In carrying out the duty imposed upon them by the terms of the bequest of the late Mr. Thomas Howard, the Council of the Society of Arts did the author the honour of inviting him to give a course of lectures on "The Development of Power at Central Stations," and its distribution either as motive power for use in factories and workshops, or as energy applied to other purposes. Energy is in these lectures to be considered as a commodity which can be produced, distributed, and sold. The special problem is to examine the advantages of producing the energy in a wholesale way; the means of conveying it to a distance and distributing it to various working centres; and the relative advantages and disadvantages of such a system compared with the method of producing the energy in the localities where it is used.

As various sources of energy and methods of producing and distributing it are available, the inquiry is a wide one. In the time at my disposal it will only be possible to pass rapidly in review the matters of most importance, leaving gaps which may be filled at some future time. That the author has more knowledge of some of the older and more mechanical methods of power distribution than of the newer methods of electrical distribution is no doubt a disadvantage. But electrical methods have already been very fully discussed. On the other hand, there may be some advantage in approaching the subject with the bias of an engineer rather than of an electrician. Granting what no doubt is true that electrical transmission will play an important part in the development of systems of power distribution, there is perhaps a popular tendency at the moment to regard too exclusively this single method and to overlook other means of power distribution which have been usefully applied, and will still be used in the future.

Those who see the electric lamp are, perhaps, a little apt to attribute to electricity too predominant a share in the production of the light. They forget the engines and boilers, which are as necessary as the dynamo in obtaining the result. Similarly, the striking success achieved in transmitting power electrically to great distances has tended to obscure the fact that other methods of power transmission are more convenient and less costly in particular cases.

Two points should be clearly kept in mind. First, that as to the production of energy in an available form, we are just where we were before modern electrical discoveries were made. The most the electrician can do is to provide a new mechanism of distribution. I should have to state the case differently if, by primary batteries employing new materials for chemical action, or by thermoelectric batteries in which heat is directly transformed into electricity, the methods of producing available energy were changed. Such things are theoretically possible. Practically they are not yet available. At present the energy to be distributed must be developed by a steam-engine or water-wheel, and the dynamo cable and electric motor merely replace the shafting, gearing, and belting, or other mechanism of transmission, performing the same functions more cheaply and effectively in certain cases it is true.

The second point is that every method of transmission will be found to have some characteristic advantages fitting it specially for particular cases. It may be conceded to the electrician that the special advantages of

electrical transmission are very strikingly apparent where power must be conveyed to very great distances. But such cases are likely to be rare. The remarkable mechanical and scientific success of the Frankfort-Lauffen experiment, in which 300 horse-power was conveyed 108 miles with a loss of only 25 per cent., has a little misled merely popular observers. The fact must be borne in mind that the cost of the power when it reached Frankfort was five times as great as that of an equal amount of power produced directly in Frankfort by a steam-engine. Transmissions to much smaller distances are the only ones likely to be often required, and for moderate distances there is choice of various methods of transmission besides the electrical method.

Reasons for Distributing Power from Central Stations.

The advantages of generating power at central stations may be enumerated thus:—

1. In generating power by steam there is economy of cost of machinery, of fuel, and of superintendence due to concentration of the engines and boilers in a single station.

2. In the case of water-power, very often it is only possible to deal with a natural waterfall by a combination of consumers, or by an association acting in the interest of many consumers for the construction of the costly permanent works required.

3. The locality for generating power may be fixed by one set of conditions; that where it is used by another set of conditions. Often it is a question of adopting a cheaper source of power at a distance, or a dearer near at hand. Thus in mining and tunnelling operations, cheap steam-power, generated at the ground surface, may be distributed in the workings to replace much more expensive hand labour. That is essentially a case of power distribution from a central station. Mr. Thwaite has recently proposed to erect large gas motor stations at collieries, and to transmit the power electrically to the nearest manufacturing centres.* Whether that is desirable is a question of finance entirely. The question is whether the economy in producing the energy covers the cost of its transmission to a distant working point.

4. Another reason for central stations arises in this way. For good or for ill population gathers into huge communities in which there is a complex development of social and industrial life. In such communities there is a constantly increasing need of mechanical power. For transit, for handling goods, for small industries, for lighting, water supply, and sanitation, new demands for mechanical power arise. At first these are met by the erection of scattered motors. This sporadic production of power is extravagantly wasteful, costly, and inconvenient. There is a chance in such cases that power distributed from a central station may be cheaper even when the cost of distribution is allowed for.

Just as it has become necessary to supersede private systems of water supply by a common supply; just as it has proved convenient to distribute coal gas, and necessary to establish a general system of sewerage, so it will probably be found convenient, and even necessary, to provide in towns of a certain importance some means of obtaining mechanical power in any desired quantity, and at a price proportional to the amount of power used. It is socialism in the field of mechanical engineering.

For the single purpose of working lifts and hoisting machinery, it has already proved remunerative to extend through the streets of London a system of nearly 60 miles in length of hydraulic mains. The extremely rapid extension of the system is worthy of note. In July, 1884, there were only 96 consumers taking power from the London Hydraulic Company's mains; in 1888, there were 720 consumers renting power; in 1892, there were 1,676 consumers renting power, and the use of the system is now extending more rapidly than at any previous period. The quantity of water distributed has increased from 317,000 gallons per week in 1884, to 6,000,000 gallons per week in 1892. In no instance has the use of hydraulic power, when once adopted, been abandoned in favour of any other system of working hoisting machinery.

There can be no doubt that when (*a*) power can be obtained with little trouble in a form involving no great amount of superintendence in working, and (*b*) the cost is proportional to the amount of power used, then a demand for the power is readily created.

Perhaps a more striking instance of the growth of a demand for power is furnished by the town of Geneva. No casual observer would have selected Geneva, with its population of 50,000, as a likely centre for a great system of power distribution. Yet the works at Geneva, which will be more fully described

* The *Engineer*, Dec. 2, 1892.

later, are perhaps the most important example of power distribution hitherto carried out in 1871. Count Turrettini obtained permission from the Municipal Council to place a water-pressure engine on the existing low pressure town mains for driving the factory of the society for manufacturing scientific instruments. In the case of this method of obtaining power proving satisfactory, he obtained the right to instal similar motors in other parts of the town. The plan proved so convenient that nine years afterwards, in 1880, there were 111 water motors driven from the low-pressure town mains, using 34,000,000 cubic feet of water annually, and paying to the Municipality £2,000 a year. The cost of the power was not small. It was charged for at 3d. to 4d. per horse-power hour, which is equivalent to a rate of £36 to £48 per horse-power year for motors working continuously for 3,000 hours in the year. Since that time a new high-pressure service has been established, the water being pumped by turbines in the Rhone. On the high-pressure service the cost of the power is less. It is charged for at about 0·7d. per horse-power hour, equivalent to £8 per horse-power year of 3,000 working hours. In 1889, the annual income from power water sold on the low-pressure system was £2,085, and on the high-pressure system £4,500. At that time the receipts for power water were increasing at the rate of £880 per annum. In 1889, the motive power distributed on the high-pressure system amounted to 1,500,000 horse-power hours, there being 79 motors, aggregating 1,279 horse-power.

This illustrates sufficiently the growth of the use of motive power distributed in a convenient form. The power used in pumping the ordinary water supply for municipal and domestic purposes is not included. It will be seen later on, that the works taken as a whole are very large and important.

The location of the windmill on the hill, and the watermill by the stream, indicates how conditions of human labour have been determined by the need of mechanical energy. The earlier cotton mills were all placed where water-power was available, although this had the disadvantage of taking them away from the places where skilled workmen were found, and from the markets for manufactured goods. In an interesting pamphlet on the "Rise of the Cotton Trade," by John Kennedy, of Ardwick-hall, written in 1815, it is stated that for some time after Arkwright's first mill was erected at Cromford, all the principal mills were built near river falls, no other power than water power having been found practically useful. After the invention of the steam-engine, manufacturing industries gathered round the coal fields. "About 1790," says Mr. Kennedy, "Mr. Watts's steam-engine began to be understood, and waterfalls became of less value. Instead of carrying the people to the power, it was found preferable to place the power amongst the people." The tendency of the conditions created by the introduction of steam-power has been to concentrate the industrial population into large communities, and to confine manufacturing operations to large factories. Economy in the production of power, economy of superintendence, and the costliness of the machinery employed, all favoured the growth of the factory system. Facilities for distributing power are of much more modern origin, and they may partially reverse the tendency to concentration, and enable small workshops and household industries to regain a commercially satisfactory position. Further, to whatever extent facility for conveying power permits the utilisation of new sources of energy, there may be a displacement of industries to new localities. The mountain districts, with abundant water-power, may have an advantage over districts where coal is obtained.

Sources of Mechanical Energy.

In these lectures motive power is treated as a commodity, producible, distributable, saleable. The first question is as to the sources from which it can be obtained.

Wind-power has been used for driving ships and mills, and now and then it is alleged that, as a source of power, wind action has been too much neglected. But its intermittence restricts its use, to work which can be intermittent also. The comparatively short periods in which the wind pressure is a considerable force make it uneconomical to attempt to do more than to utilise very moderate winds. On the other hand, the occasional great intensity of wind action during short periods involves the necessity that structures exposed to its action should be of excessive strength and costliness.

Tidal action might, no doubt, afford an enormous amount of mechanical energy. But up to the present time it has been found that the cost of embankments and machinery for utilising tidal action is so great as to prohibit its employment. The direct action of the sun's heat could be employed, but here, again,

the cost of utilisation exceeds the value of the power obtained. Considered practically and commercially, there are only three sources of mechanical energy of industrial importance :—

1. The muscular energy of animals.

2. The gravitation of water falling from a higher to a lower level, and automatically restored to the higher level by the sun.

3. The conversion of heat into mechanical energy, the heat being derived from the combustion of fuels.

As to the muscular energy of animals, the question of distribution does not arise. It is convenient, also, to consider heat energy before considering water-power.

Solid Fuel.—By far the most important source of mechanical energy is solid fuel, and chiefly the various descriptions of coal. Coal is obtainable in very many localities, and is transportable anywhere at comparatively small cost. There are, however, certain disadvantages in obtaining energy directly from coal. First of all, there is the fact that, when burned in an open furnace, one-fifth to one-fourth of the heat escapes with the products of combustion. Next, there is the fundamental disadvantage of the transformation of heat into mechanical energy by a steam-engine, that at most three-eighths to four-fifths of the heat supplied can be transformed, the remainder being rejected in the condenser. The $\frac{3}{10}$ths of the whole heat of the fuel which it is possible to transform by a steam-engine is further reduced by imperfections and losses in the steam-engine itself. Then the attendance required in the case of steam-engines and boilers, the risk, the difficulty of preventing smoke and of disposing of ashes, are all drawbacks to the general use of steam-power.

Gaseous Fuel.—Many of the disadvantages of solid fuel are diminished by employing the coal to produce gas, and using the gas in internal furnace or gas-engines. Gas can be transported with great convenience in pipes, and gas-engines require less attendance, and work with a greater temperature range and a higher thermal efficiency, than steam-engines. In transforming heat into work small gas-engines are enormously more efficient than small non-condensing steam-engines. On the other hand, ordinary lighting gas, taxed as it is with costs of distribution due to its ordinary application for lighting purposes is more expensive for a given calorific value than raw coal. The cost of ordinary lighting gas is increased, both by the need of a large generating plant, to meet the excessive fluctuation of demand for lighting, and by the large distributing charges involved in supplying a very great number of small consumers. If gas were made specially for heating and power purposes—either coal-gas at low luminous power, or water-gas, or producer-gas—it could probably be distributed to power users at less than half the present price of coal-gas. Used in gas-engines, it would then compete, on nearly equal terms, as regards cost, with solid coal, and would have many subordinate advantages.

M. Aimé Witz has shown, by direct experiment, that a gas-engine worked with Dowson gas will give an effective horse-power, at a total cost, including all charges for fuel, interest, and depreciation, not greater than that at which an effective horse-power can be obtained by a good boiler and good compound steam-engine. It is impossible to predict how far gas-engines will replace steam-engines, but at present they have two disadvantages. They are more restricted in size than steam-engines, and they work less economically with light loads.

Production of Power by Burning Town Refuse.—There is another source of heat energy—another fuel—to which Professor G. Forbes has called special attention, that is, town or ashbin refuse. In addition to ordinary sewage, which is got rid of in well-known ways, there is in towns a large quantity of refuse, which can only be got rid of effectually and innocuously by burning. Even when the heat generated is wasted, it appears that burning is the least costly method of refuse disposal. It is a fuel, therefore, which, like water-power, costs nothing, except for the machinery for utilising it.

Various forms of destructors have been tried. It appears that for successful and inoffensive working, it is necessary to use a large quantity of air—7 or 8 lbs. per pound of refuse—and that combustion is best effected by a forced draught. Then a large quantity of products of combustion escape from the furnace at a high temperature. By interposing a steam boiler between the furnace and the chimney a by no means unimportant amount of heat can be utilised.

Mr. Watson gives some data of the heat developed in the working of Horsfall furnaces at Leeds, but they are not quite complete or consistent. He states that calculation from an analysis of the escaping gases showed that 4,800 lbs. of water could be evaporated by the heat produced by the combustion of a ton of

ashbin refuse. In this calculation it appears that the data assumed were that in a destructor cell burning 6 tons of refuse in 24 hours, the escaping gases contained 4·8 per cent. of carbonic acid. The quantity of air passing into the furnace is stated to be 44 tons per day, and the temperature of the gases 2,000°. The total weight of the furnace gases must then have been 44 + 6 = 50 tons per 24 hours, or, say, 4,600 lbs. per hour; 4·8 per cent. of carbonic acid corresponds to 1·3 per cent. of carbon. Hence the carbon in the furnace gases must have been 0·013 × 4,600 = 59·8 lbs. per hour. The combustion of this would yield 14,500 × 59·8 = 867,100 thermal units. But also according to the data 4,600 lbs. of furnace gases were raised from 60° to 2,000° per hour. This would require 2,231,000 thermal units. These quantities are irreconcileable, and it would seem that either the quantity of air or its temperature have been over-estimated. It is true that the heat carried into the furnace by the steam jet has to be deducted from the latter quantity in finding the heat disengaged by the ashbin refuse. From some other experiments it appears that the steam jet may have delivered 250 lbs. of steam per cell per hour. The total heat of this would be 287,500 thermal units. If this is deducted from the 2,231,000 thermal units, it still leaves an enormous discrepancy.

Mr. Watson made some other experiments at Oldham. Six cells were used, burning 1½ tons of refuse per hour. The gases passed through a multitubular boiler, 7 feet in diameter and 12 feet long, and the feed was measured by a meter. The temperature of the gases was 2,019° before reaching the boiler, and 900° after leaving it. Thus only about two-thirds of the available temperature range was utilised. In two trials the mean evaporation was found to be 2,780 lbs. per hour. Deducting 1,500 lbs. of steam used for the steam jets, there was a surplus evaporation of 1,280 lbs. per hour, or, say, 50 horse-power of energy from six cells burning 1½ tons per hour. If a boiler with larger heating surface had been used, possibly an evaporation one-third greater would have been obtained, or say 3,700 lbs. per hour. Deducting 1,500 lbs. used in the steam jets there would be a surplus or available steam supply of 2,200 lbs. per hour or, say, 88 horse-power from six cells, burning 1½ tons of refuse per hour. This gives about 40 lbs. of refuse per effective horse-power hour.

Now the chief difficulty in using the available energy of destructors is this. The refuse must be burned at a regular and almost uniform rate. But demands for power for most purposes are varying demands. It is because later a method of storing heat is to be considered that destructors have been referred to in some detail.

Generation of Power by Steam.—Conditions of Economy and of Waste.

Sir F. Bramwell, in an address to the Institution of Civil Engineers, in 1885, indicated very clearly in a convenient phrase those conditions involving waste of fuel in steam-power production which are avoided by central station working. He said that we were "every day becoming more alive to the benefit where little power is required, or where considerable power is required intermittently, of deriving that power from a central source." Where little power is required the steam-engine is costly, uneconomical, and inconvenient. Where great power is required intermittently both engines and boilers work in conditions extremely unfavourable to economy. It is necessary to examine into these cases more in detail, because it is the wastefulness of working in such conditions which makes central stations desirable.

Table I. gives a careful selection of the most trustworthy results of steam-engine experimental trials. In such trials it may be assumed that everything is working at its best, and that the steam and coal consumption is the smallest realisable with different engine and boiler plants. In all these trials the engines were worked with, at any rate, an approximation to the most economical load. It will be seen that the steam and coal consumption is less for large engines than for small engines; less for quick engines than for slow ones; and less for compound and triple engines than for simple engines. Even under favourable test trial conditions, and with an economical load, there is considerable variation in the amount of coal and steam required per horse-power.

Taking the most favourable results which can be regarded as not exceptional, it appears that in test trials, with constant and full load, the expenditure of steam and coal is about as follows:—

	Per Ind. H.P. hour.		Per effective H.P. hour.	
	Coal. lbs.	Steam. lbs.	Coal. lbs.	Steam. lbs.
Non-condensing engine ...	1·80	16·5	2·00	18·0
Condensing engine	1·50	13·5	1·75	15·8

TABLE I.

COAL AND STEAM CONSUMPTION IN STEAM-ENGINES IN SPECIAL TRIALS.

	Authority.	Indicated H.P.	Boiler pressure. lbs. per sq. in.	Piston speed. Ft. per min.	Steam per I.H.P. per hour. lbs.	Coal per I.H.P. hour. lbs.
NON-CONDENSING ENGINES.						
SIMPLE.						
Semi-portable	Unwin	5	61	263	65	6·5
Small Brotherhood		13	—	—	41	—
Small double-acting	Donkin	6	35	211	44	[5·0]
Willans slow	Willans	9	44	200	41·8	—
,, ,,	,,	20	112	224	30·2	—
,, fast	,,	16	36	394	42·8	—
,, ,,	,,	26	74	409	32·6	—
,, ,,	,,	34	122	406	26·9	—
Reynolds-Corliss	Hill	137	97	602	23·9	2·4
Harris	,,	134	96	606	22·0	2·2
Wheelock	,,	140	96	608	24·9	2·5
COMPOUND.						
Willans slow	Willans	10	84	122	27·0	—
,, ,,	,,	11	103	123	24·7	—
,, ,,	,,	13	120	131	23·4	[2·6]
,, fast	,,	33	114	403	21·4	—
,, ,,		36	135	406	20·4	—
,, ,,		40	165	401	19·2	[2·1]
TRIPLE.						
Willans	Willans	39	172	400	18·5	[2·1]
CONDENSING ENGINES.						
SIMPLE.						
Beam pumping, jackets	Mair	123	42	223	22·0	[2·5]
,, ,, ,,	,,	120	45	240	21·3	—
Corliss. jackets	Longridge	488	61	520	19·3	[2·1]
,, no jackets	,,	508	60	520	19·8	—
Harris-Corliss	Hill	166	90	606	19·4	1·9
Reynolds-Corliss	,,	163	96	603	19·5	1·9
Wheelock	,,	158	96	596	19·3	1·9
Sulzer, jacketed	Linde	395	75	272	19·7	—
,, ,,	,,	284	87	372	18·4	—
COMPOUND.						
Semi-portable	Unwin	6	101	—	35·7	4·1
Tandem mill	Donkin	57	53	—	20·5	1·9
Tandem pumping, no jackets	Mair	177	70	692	20·9	—
Receiver ,, jackets	,,	127	61	264	14·8	—
Worthington pump, jackets	Mair and Unwin	296	75	124	17·4	—
,, ,, ,,	,,	255	60	121	17·7	1·78
Tandem mill, no jackets	Longridge	888	87	442	17·8	1·78
,, ,, ,,	,,	862	87	442	19·6	2·15
Receiver ,, ,,	,,	314	95	478	17·0	1·96
,, ,, jackets	,,	338	95	487	17·2	2·04
Beam pumping ,,	Leavitt	252	99	237	13·9	—
,, ,, ,,	,,	290	99	241	14·2	—
Sulzer jackets	Sulzer	267	90	690	14·0	[1·6]
,, ,,	Uincotte	135	90	395	15·3	—
,, ,,	Soldini	272	110	590	15·3	—
TRIPLE.						
Sulzer jackets	Sulzer	360	145	—	11·7	—
,, ,,	Schröter	108	156	460	12·2	—
Maschinenfabrik (Augsburg) jackets	,,	700	145	596	12·45	—
MARINE ENGINES.						
COMPOUND.						
Fusiyama, no jackets	Kennedy	371	57	306	21·2	2·66
Colchester ,, ,,	,,	1,979	81	522	21·7	2·90
TRIPLE.						
Meteor jackets	Kennedy	1,994	145	574	15·0	2·01
Tartar	,,	1,087	144	490	1[illegible]·8	1·77

These may be regarded as minimum values, rarely surpassed by the most efficient machinery, and only reached with very good machinery in the favourable conditions of a test trial.

It is much more difficult to get the consumption of coal by engines in ordinary daily work. What is known shows that the consumption is greater than in engine trials. Some comparatively large pumping engines, which work with a steady load night and day, and which worked with 2 lbs. of coal per effective or pump horse-power on a test trial, used 2·7 lbs. in ordinary working. The consumption was measured over many weeks, during which they were working 90 per cent· of the whole time. Here the consumption is 35 per cent. greater in ordinary work than in a test trial.

The large pumping engines of the Hydraulic Power Company are less favourably circumstanced for economy. They gave an indicated horse-power on trial with 2·19 lbs. of coal per hour. In ordinary work they are stated to use 2·93, or about 35 per cent. more. These engines have a fairly steady load during the day and a smaller load at night.

If such a case as that of an electric lighting station is considered, where the load fluctuates very greatly, the maximum load being often four times the mean load, and the minimum load one-twentieth of the mean load, then the consumption per horse-power is very much greater. Mr. Crompton has given the figures for the Kensington station, which has excellent Willans compound non-condensing engines. Those engines will work with less than 2 lbs. of coal per effective horse-power in trials at full load. The results obtained in ordinary workings were as follows :—

TABLE II.—ENGINES IN ELECTRIC CENTRAL STATIONS.

Year.	Coal used in lbs. per Hour.		
	Per Electrical Unit Generated.	Per Effective H.P.	Per Indicated H.P.
1886..	12	8·4	6·5
1890..	8	5·6	4·35
1892..	7	4·9	3·8

In the discussion on Mr. Crompton's paper, instances were given of coal consumption at electrical stations still larger than any of these. Probably up to the present the consumption has in no case been less than 6 lbs. per unit generated; 3·8 lbs. per effective horse-power; or 3·3 lbs. per indicated horse-power. This large consumption will be traced later to two classes of waste, engine waste and boiler waste, due both of them to the inefficiency caused by variation of load.*

In the case of small isolated motors, not generally of very good construction or well proportioned for their work, still more extravagant results have been observed. The following Table gives some results obtained with small workshop engines in Birmingham :—

TABLE III. — COAL CONSUMPTION PER INDICATED HORSE-POWER IN SMALL ENGINES AT BIRMINGHAM.

Nominal H.P.	Probable I.H.P. at Full Load.	Actual Average I.H.P. during the Observations.	Coal Consumption in lbs. per I.H.P. hour during the Observations.
4	12	2·95	36
15	45	7·37	21·25
20	60	8·20	22·61
15	45	8·60	18·13
25	75	23·64	11·68
20	60	19·08	9·53
20	60	20·00	8·50

These last results are interesting only for this reason that it is such uneconomical small engines which are displaced when central station power distribution is introduced. It is because these small engines are so extravagant that power can be distributed from a central station at a profit. As to the case of electric light stations, seeing that they are central stations of the type specially considered in these lectures, it is desirable to analyse more in detail the causes of waste.

The Chief Secondary Cause of Loss or Waste in Heat Motors.—Thermodynamics shows that the efficiency of heat motors cannot exceed a certain limit, depending on the range of temperature at which the motor works. With the range of temperature practically available a steam-engine might

* The latest Board of Trade returns from electric lighting stations confirm these figures. Taking the largest and best stations, the consumption of coal varies in different cases from 7 lbs. to 12 lbs. per unit of electricity generated. It is more than this per unit sold.

convert three-eighths, and a gas-engine one-half of the heat supply into work. No actual engine reaches even approximately this thermal efficiency. Part of the losses are due to bad construction or bad management, but a part are practically unavoidable. The principal cause of the practically unavoidable waste of heat energy is essentially the same in steam-engines and gas-engines; it is a consequence of the enclosure of the hot working fluid in conducting metallic walls. In steam-engines the cylinder walls condense steam during admission, the condensed steam evaporating and carrying off heat to the condenser or the atmosphere during the period of exhaust. This exhaust waste increases with the ratio of the admission surface in the cylinder to the weight of steam used per stroke. In the same engine, therefore, it increases for light loads because more surface is exposed during admission per pound of steam used. It is greater when the engine works slowly than when it works fast, the piston effort being the same. The evil can be diminished, but not entirely overcome by steam-jackets, or by superheating. It is an evil specially prejudicial when engines are used which are too large for the work to be done.

In gas-engines it is necessary, to prevent destruction of the cylinder by the high temperature of the burning gases, to enclose it in a water-jacket. M. Witz has shown that it is due to the cooling action of this water-jacketed wall that part of the gas is kept below the temperature of combustion. The jacket, therefore, diminishes the efficiency of the engine not only by directly abstracting heat, but by preventing the full development of the gas pressure early in the stroke. As in steam-engines, the evil is greater the greater the wall surface exposed at the moment of explosion. This appears to be the principal reason why initial compression of the gases is necessary for good efficiency. The gases reduced by compression to a smaller volume are exposed at the moment of ignition to a smaller area of cylinder wall.

It is useful to get a clear numerical idea of the relative importance of the cylinder wall action and the other actions during a stroke, for this cylinder wall action is the principal factor in the inefficiency due to variable load or arising out of the use of underloaded engines, both matters of importance in considering the advantages of distribution of power. Prof. Develshauvers Dery has shown* how the heat exchange between the steam and the cylinder wall during the stroke may be represented by a diagram on the same scale as the indicator diagram. Fig. 1 shows such a diagram drawn for the data of one of Mr. Mair Rumley's engine trials. The engine was a single cylinder beam engine with jacket, working at about 4½ expansions, and furnishing 123 indicated horse-power. The total steam used per stroke was 1·14 lb., or 31 cubic inches of water. The whole of this, if condensed and spread over the cylinder wall, would make a layer less than one-hundredth of an inch thick. The range of temperature between the initial steam temperature and the exhaust temperature may be taken roughly as 200°, and about 30 per cent. of the steam was condensed during admission. The whole heat of this initially condensed steam would only be sufficient to heat a very thin layer of the cylinder wall from the exhaust to the admission temperature.

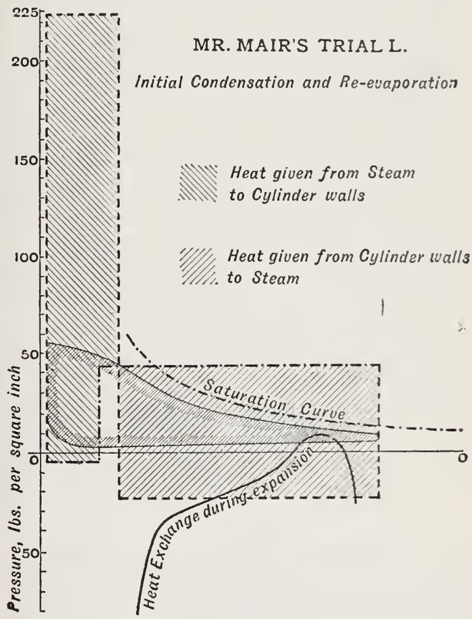


FIG. 1.

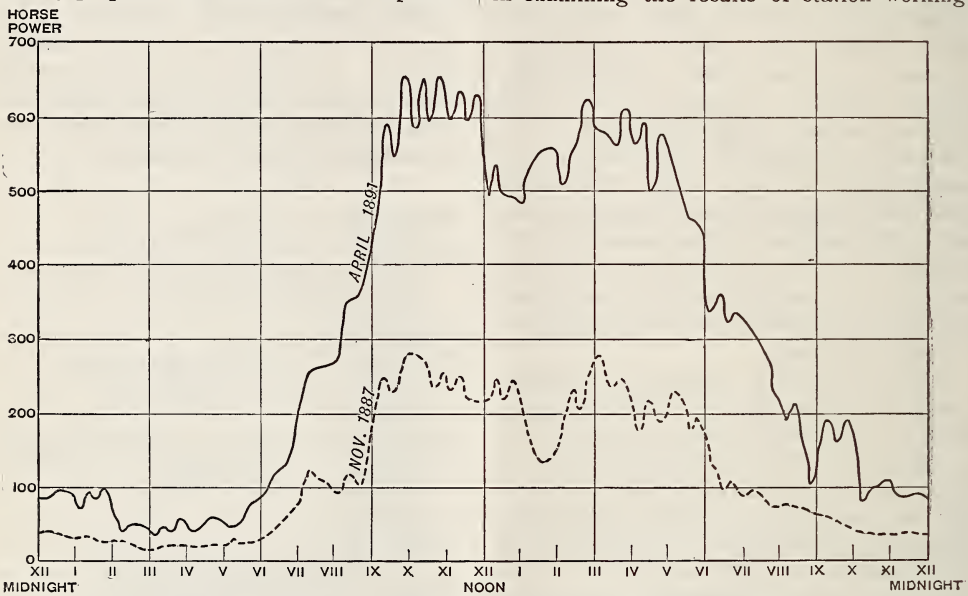
The dark shaded line in the figure is the indicator diagram of the engine. The saturation curve shows where the expansion line of the diagram should have been if there had been no condensation. The two shaded areas represent to the same scale as the indicator diagram the heat given to the cylinder wall during admission and compression, and ab-

* "Investigation of the heat expenditure in steam-engines." "Proc. Inst. of Civil Engineers," vol. xcviii., 1889.

stracted from it during expansion and exhaust. They represent heat quantities wasted. It will be seen easily that the cylinder wall action involves larger quantities of heat than the whole of the heat employed in doing useful work.

Load Curve and Load Factor.—A curve, the abcissæ of which represent time, and the ordinates the rate of expenditure, is called a load curve, and such curves are very commonly drawn for a period of 24 hours' working, because, apart from seasonal fluctuations, a day is a natural period in the operation of a power plant. The ordinates may be horse-power, or volt-ampères, or units of any other quantity proportional to the rate of expenditure of energy. The area of the curve represents the total amount of energy for the period considered. A load curve may be drawn for a single engine or machine, or for a plant of many engines or machines. The load line for a central station is that to which attention is to be directed. The ordinate of such a station load curve represents the sum of the energy expended at the moment per unit of time by all the engines or machines then in operation.

Load curves for particular cases have no doubt been frequently drawn, and the influence of fluctuation in the rate of working on economy has been noted. But it is due to Mr. Crompton that the use of the load curve in examining the results of station working,



LOAD CURVES. LONDON HYDRAULIC POWER STATION.

1887 CURVE MAXIMUM = 280 LOAD FACTOR =·420

1891 CURVE MAXIMUM = 655 LOAD FACTOR =·460

Fig. 2.

and in discriminating the causes of differences in the results obtained in different stations was first clearly indicated.*

It can be directly inferred from the examples given in Mr. Crompton's paper that the cost of working per unit of mechanical or electrical energy distributed in different electric lighting stations depends very intimately on the form of the load curve. Mr. Crompton introduced a term, "load factor," to express the coefficient of fluctuation of the rate of working. There may be various load factors, according to the precise fluctuation considered. But for the object at present in view, the consideration of the influence of variation of load on the efficiency of steam plant, the load factor may be taken to be the ratio of the area of a day's load curve to the area of a rectangle enclosing it. It is equally the ratio of the average load during the day to the maximum load at any time during the day. The plant must be large enough for the maximum load. The income depends on the mean amount of energy delivered. The efficiency of the engines depends on the load factor. The cost of a day's working depends partly on the average output, partly on the load factor.

Fig. 2 gives two load curves for a day's working of one of the stations of the London

* "Electrical Energy." "Proc. Inst. Civil Engineers."

Hydraulic Supply Company. These indicate the kind of fluctuation of demand which occurs in a central station supplying power for a large number of intermittently working machines, chiefly lifts and hoisting machines. Such machines are in frequent use in the day and are little used at night. The demand for power water pumped by the engines at the station is large and pretty constant from 9 a.m. to 5 p.m. During the remaining hours the demand is small. The load factor for the day, understood as defined above, is 0·41 in 1887, and 0·46 in 1890, when the system had been considerably extended. This shows that as the number of consumers supplied is greater, the demand is more uniform.

Fig. 3 shows load curves for the London Gas and Coke Company. A gas generating station is essentially a central station supplying and distributing a means of producing energy either for lighting, heating, or power purposes. The ordinates in this case represent cubic feet of gas supplied per hour. If, say, 26 cubic feet of gas per hour is assumed to be capable of furnishing a horse-power, it is easily seen that the ordinates of the curves

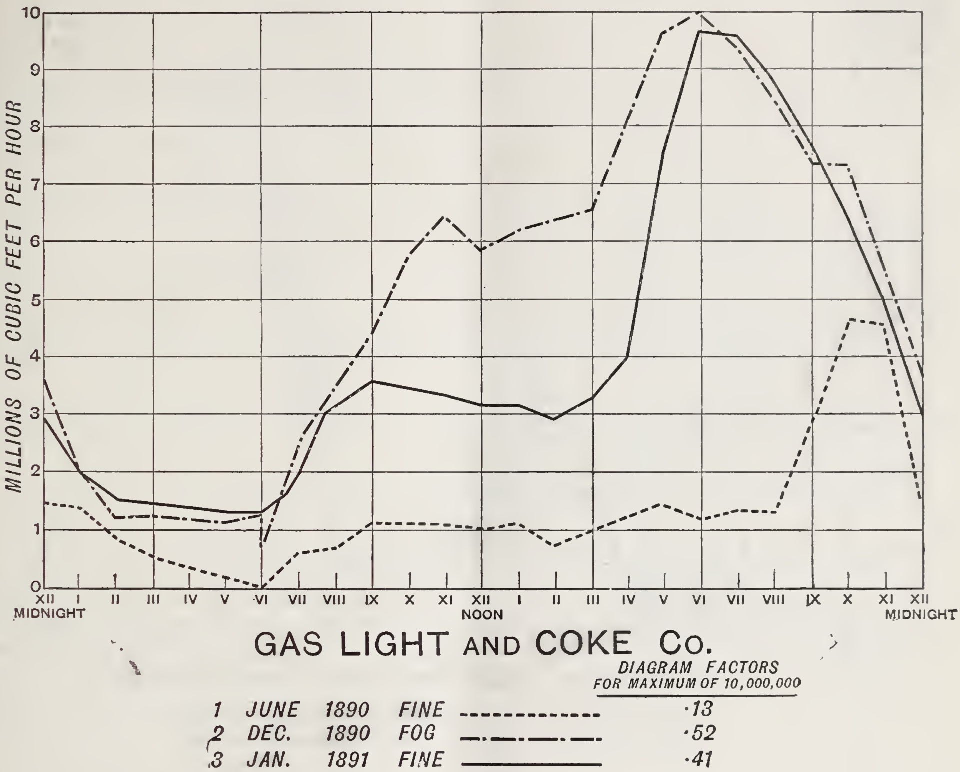


Fig. 3.

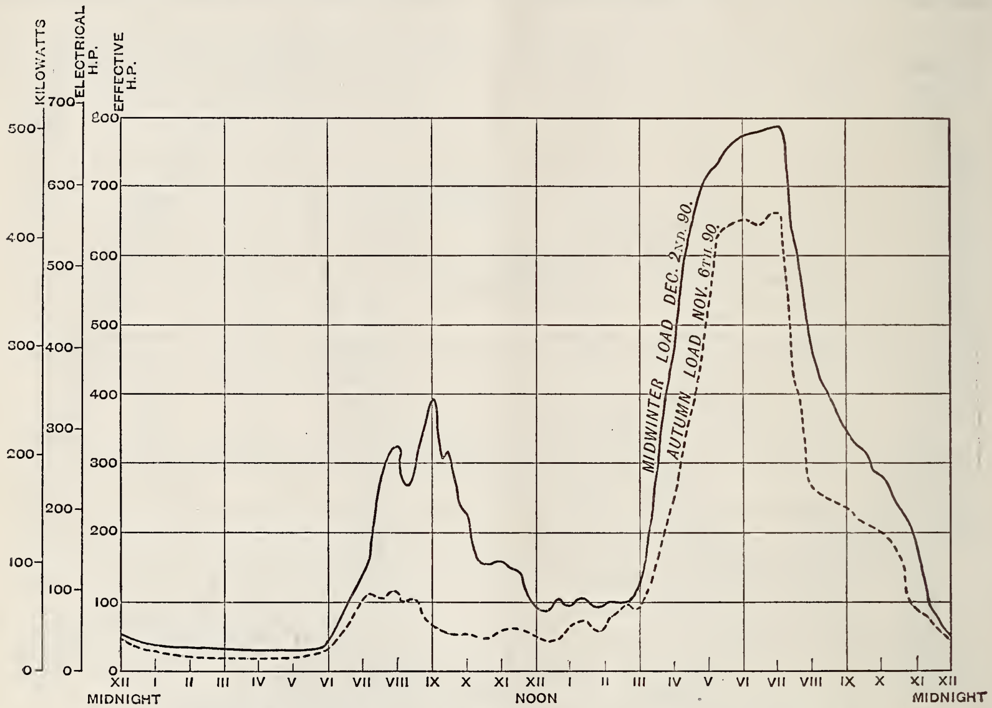
to a suitable scale represent equally horses' power of energy supplied. In the case of the Gas and Coke Company, the largest demand is for lighting, and this is greatest in the evening. But there is also a considerable demand during the day for gas for heating and for power. The daily diagram factor was 0·41 for a day in January, falling to 0·27 for a day in June. On a foggy day in December it rose to 0·52.

Fig. 4 gives load curves for the Kensington Electric Lighting Station. As practically the whole of the electricity generated is used for lighting purposes, the period of large demand is short, and the fluctuation of demand greater than in either of the previous cases. The daily load foctor is 0·24 for one of the curves and 0·32 for the other. But for the partial use of storage batteries the load factor would have been smaller still.

Indicated and Effective Horse-power.—In questions of power distribution, it is clear that it is the effective horse-power delivered at the crank shaft, and not the indicated horse-power developed in the cylinder, which has to be considered. It is due to the difficulty of

determining in most cases the mechanical efficiency of an engine that engineers have been content to reckon on the indicated horse-power. It is true that the engine friction is not a very large fraction of the power developed in full load trials, nor does this fraction vary very greatly at full load for different engines. But it is erroneous to assume tacitly that the engine friction is, in all cases, a quantity of relatively little importance, or that it is immaterial whether the indicated or the effective horse-power is used in calculations.

Influence of Mechanical Efficiency on the Economy of Working with a Varying Load.—The mechanical efficiency of steam-engines, or the ratio of the effective to the indicated power at full load is 0·8 to 0·85 for small engines, and may reach at least 0·9 for large engines. It is a little greater for non-condensing than for condensing engines, and for simple than for compound. A triple expansion engine, constructed by Messrs. McLaren, tested on a brake, gave 122 indicated horse-power, and 107 on the brake, an



LOAD CURVES. KENSINGTON COURT ELECTRIC STATION.

AUTUMN CURVE MAXIMUM = 670 LOAD FACTOR = ·235
WINTER CURVE MAXIMUM = 800 LOAD FACTOR = ·310

FIG. 4.

efficiency of 0·88 The loss of power due to engine friction is not very great or variable so long as the engines are worked at full load. It is quite otherwise, however, at light loads, and the extent to which this affects the economy of working has been overlooked.

Many experiments show that the engine friction is nearly the same at all loads. Suppose that at full load an engine gives 100 indicated horse-power and 85 effective horse-power. If the friction is constant, then for smaller loads the efficiency diminishes as follows:—

TABLE IV.—MECHANICAL EFFICIENCY OF ENGINES WITH VARYING LOAD.

Indicated H.P.	Effective H.P.	Efficiency.
100	85	·85
75	60	·80
50	35	·70
25	10	·40

The steam and coal used depend on the indicated power—the work done on the effec-

tive power. The decrease of mechanical efficiency for light loads has a serious effect on the economy of working with a varying load.

Careful experiments on mechanical efficiency with varying loads are not very numerous. It is useful, therefore, to give the results of some experiments on a Corliss engine of about 180 indicated horse-power at full load. This engine was tried with a brake at Creusot, both condensing and non-condensing. It was found that the results agreed approximately with the following equations :—

Condensing ...... $T_e = 0{\cdot}902\ T_i - 16$
Non-condensing.. $T_e = 0{\cdot}945\ T_i - 12$

equations which give results not differing greatly from those obtained by assuming the friction constant. The following are the calculated values of the efficiency :—

TABLE V.—MECHANICAL EFFICIENCY OF CORLISS ENGINE WITH VARYING LOAD.

Actual Effective Power. / Power at Full Load.	Mechanical Efficiency. Condensing.	Mechanical Efficiency. Non-condensing.
1·0	·82	·86
·75	·79	·83
·50	·74	·78
·25	·63	·67
·125	·48	·52

Influence of the Loss due to Back Pressure on the Economy of Steam-engine Working.— Besides engine friction, there is another waste of energy in the steam-engine which has, to an even greater extent, been overlooked. The effective power is less than the indicated power by the engine friction; but the indicated power itself is less than the work done by the steam by the amount of work done against back pressure.

In condensing engines the back pressure is comparatively small, but in non-condensing engines the back pressure exceeds 15 lbs. per square inch. Its influence on economy, even at full load, is considerable, and at light loads it may become excessively great.

In engines working as most engines do, at constant speed, the work against back pressure is nearly independent of the load.

In interpreting an indicator diagram (Fig. 5) the total work done by the steam on the piston, called by some continental writers the absolute indicated work, is the area *O e a b c d.* The work afterwards wasted in overcoming back pressure is *O e f c d.* The difference

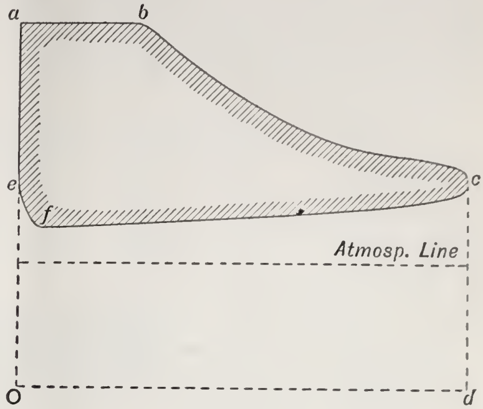


FIG. 5.

is the effective work, *e a b c f.* The quantity of steam used depends on the absolute indicated work; the useful energy obtained on the effective indicated work. If the back pressure work is constant, it becomes a larger and larger fraction of the absolute work as the load on the engine is diminished.

Suppose in a non-condensing engine the work against back-pressure is 20 per cent. of the absolute indicated work of the steam at full load. Then for other loads the work is distributed thus :—

TABLE VI.—WASTE OF WORK DUE TO BACK PRESSURE.

Absolute indicated work of steam.	Work against back pressure.	Net or effective indicated work.
H.P.	H.P.	H.P.
125	25	100
75	25	50
50	25	25
$37\frac{1}{2}$	25	$12\frac{1}{2}$
25	25	0

The following is calculated from the indicator diagrams of a compound engine working at nearly constant speed with a varying load. The waste work against atmospheric pressure is calculated exclusively of the waste of work due to excess back pressure due to resistance of passages, &c. It represents, therefore, work wasted in a non-condensing engine, which is almost entirely saved in a condensing engine.

TABLE VII.—WORK LOST IN PUMPING AGAINST THE ATMOSPHERE.

No. of Trial.	Effective work in H.P.		Total effective work. H.P.	Work wasted against atmospheric pressure. H.P.
	H.P. Cylinder.	L.P. Cylinder.		
1	41·1	28·9	70·0	98·5
2	49·3	38·4	87·7	100·0
3	68·7	48·6	117·3	102·0
4	64·4	60·2	124·6	103·0
5	87·2	78·2	165·4	102·0
6	90·4	90·1	180·5	100·0

The work wasted is equal to $\frac{5}{9}$ths of the effective work at full load, and to $1\frac{3}{7}$ths of the effective work at the lightest load.

Influence of the Type of Engine, the Speed and the Mode of Regulation on the Thermal Efficiency.—It has already been pointed out that there are very large thermal losses in heat engines which are not shown on the indicator diagram, and which have a very important effect on economy of working. Those thermal losses are greater also at light loads than at full load, and they vary very much with the type of engine and some other conditions of working.

CONDENSING ENGINE

	VARIATION OF I.H.P. BY	KIND OF ENGINE
CASE 1. —+—+—	VARYING SPEED	$r = 4$ $p_1 = 110$
CASE 2. a ——— b - - - - - c —·—·—	VARYING BOILER PRESSURE	$r = 4$ FAST 50 REVS. PER MIN. MODERATE 25 ,, ,, ,, SLOW 12·5 ,, ,, ,,
CASE 3. a ——— b - - - - - c —·—·—	VARYING EXPANSION	$p_1 = 110$ FAST 50 REVS. PER MIN. MODERATE 25 ,, ,, ,, SLOW 12½ ,, ,, ,,

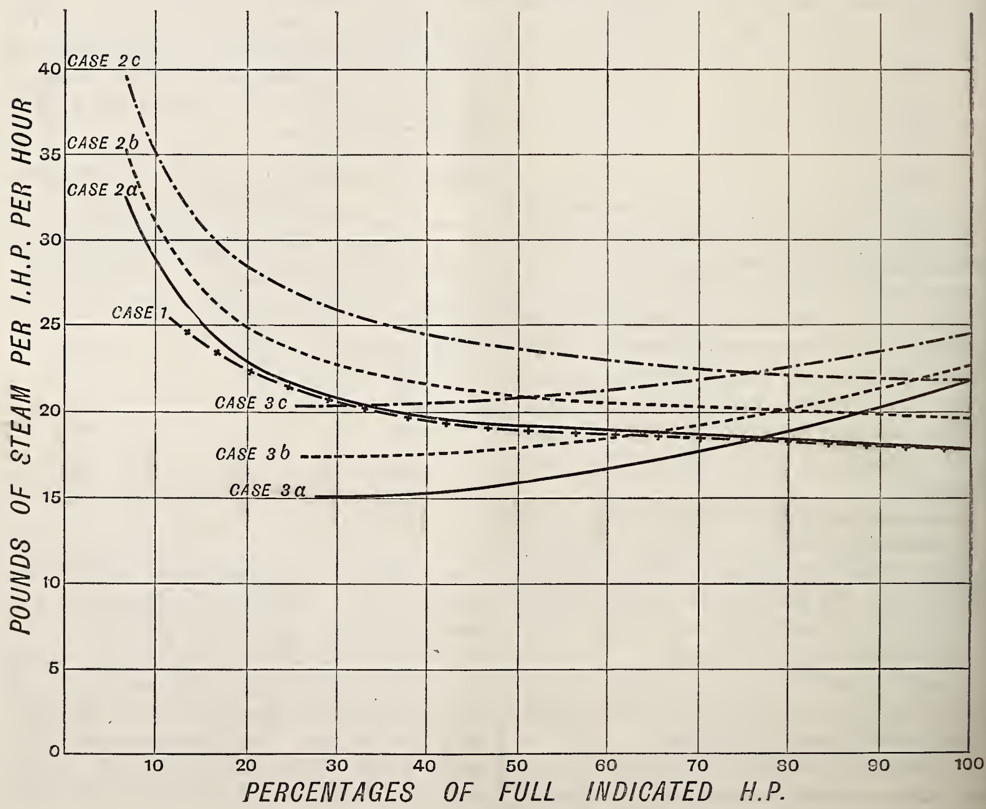


FIG. 6.

It is possible to get a good idea of the influence of conditions of working on the thermal efficiency in this way. Prof. Cotterill* has found a means of calculating the cylinder condensation in an unjacketed simple engine. The rest of the steam used can be ascertained in other ways. By examining the steam consumption in a variety of conditions for such an engine, a good deal of insight may be gained applicable to all cases. With the aid of Prof. Cotterill's formula, the steam consumption has been calculated for a number of cases, and the results plotted in curves.

An engine has been assumed working at

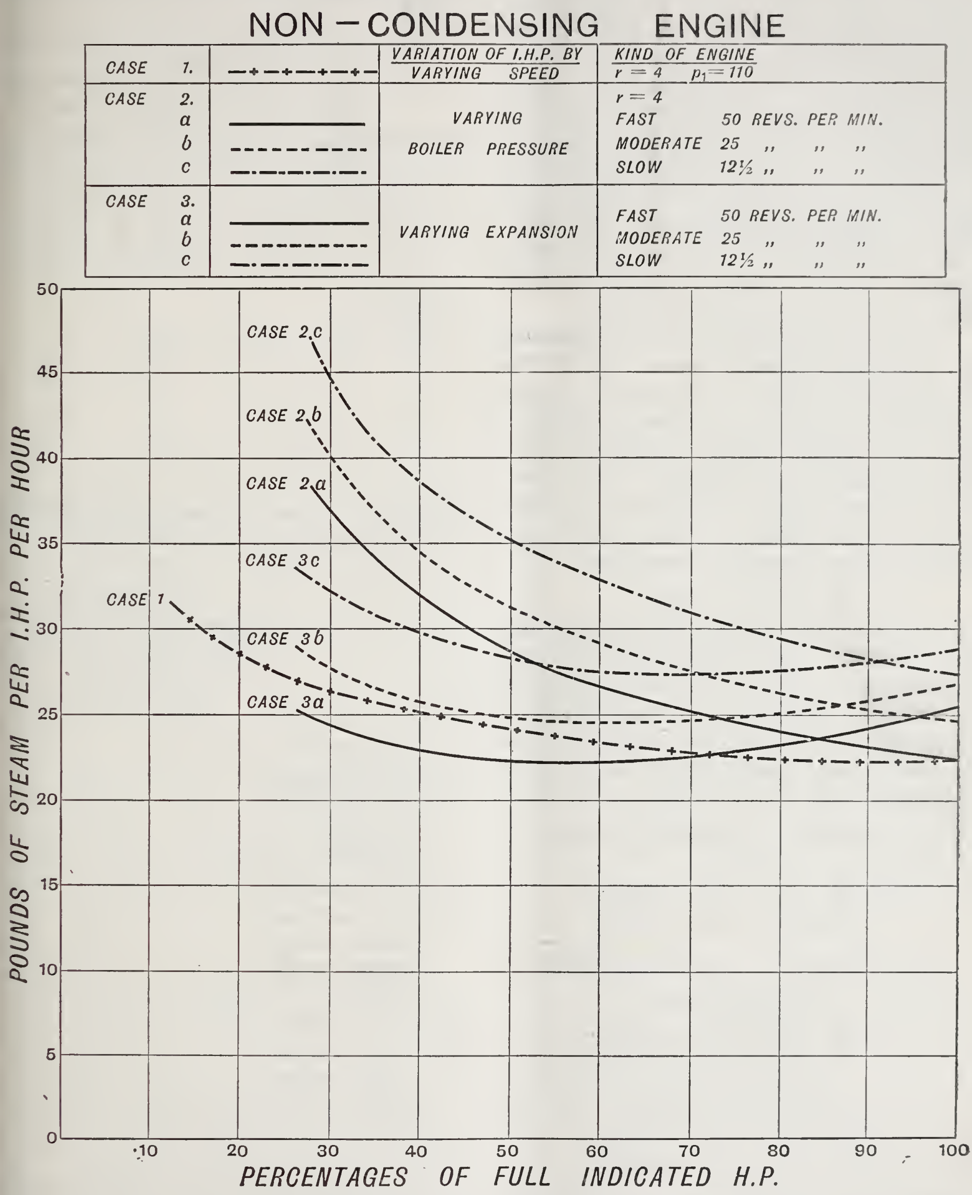


Fig. 7.

full load in given conditions. Then the effect on the steam consumption of varying the speed, the initial steam pressure and the ratio of expansion has been calculated. The results have been plotted in curves, which give the steam consumption in lbs. per indicated horse-power hour at any fraction of full load.

There are three ways in which the conditions of working may be varied when the power de-

*. "The Steam Engine," 1890, chap. xi.

mand varies. The speed may be varied, as is often done in the case of pumping engines. The initial steam pressure may be varied, which alters the weight of steam used per stroke by altering the density of the steam. This may be done by varying the boiler pressure or by throttling the steam. Lastly, the expansion may be varied. A case of an engine has been taken, and the effect on the steam consumption of these different ways of varying the power has been calculated. Figs. 6 and 7 (pp. 902 and 903) show by curves the results both for condensing and non-condensing engines. The results are theoretical, but they have been compared with data from various engines, and they agree with them quite closely enough for the purpose of comparison. Strictly, however, these results are applicable only to unjacketed engines.

Mr. Willans's Law.—In the discussion on Mr. Crompton's paper,* the late Mr. P. W. Willans first stated a remarkable simple approximate law for the total steam consumption of an engine working at constant speed with a constant ratio of expansion. He found that the total weight of steam used per hour for any engine in the conditions stated was given by a linear equation of the form—

$$W = a + b \text{ H.P.},$$

where H.P. is the horse-power at which the engine works. Thus, for an engine of 100 indicated horse-power at full load he obtained the following equations, in which I.H.P. is put for indicated horse-power, and E.H.P. for electrical horse-power, which is taken at 80 per cent. of the indicated power:—

Non-condensing Triple (about 6·7 expansions).

$$W = 450 + 13{\cdot}75 \text{ I.H.P.}$$
$$= 725 + 13{\cdot}75 \text{ E.H.P.}$$

Non-condensing Compound (about 4·45 expansions).

$$W = 525 + 16{\cdot}25 \text{ I.H.P.}$$
$$850 + 16{\cdot}25 \text{ E.H.P.}$$

Condensing Triple.

$$W = 112 + 13{\cdot}75 \text{ I.H.P.}$$
$$= 377 + 13{\cdot}75 \text{ E.H.P.}$$

If instead of calculating the total steam per hour W, we calculate the steam per horse-power hour, we get results which, plotted like the previous diagrams, give rectangular hyperbolas, curves which agree closely with the theoretical curves for the case of varying pressure previously given. To show the great variation of steam consumption, these values are given in the following Tables for full load, half load, quarter load, and one-eighth load:—

* "Proc. Inst. Civil Engineers," vol. cvi. p. 62.

TABLE VIII.—STEAM CONSUMPTION, LBS. PER I.H.P. HOUR, AND LBS. PER ELECTRICAL H.P. HOUR.

	Non-Condensing.		Condensing Triple.
INDICATED H.P.	Compound.	Triple.	
100	21·5	18·2	14·9
50	26·7	22·7	16·0
25	37·2	31·7	18·2
12½	58·2	49·8	22 7
ELECTRICAL H.P.			
80	26·9	22·8	18·5
40	37·5	31·9	23·2
20	58·7	50·0	32·6
10	101·2	86·2	51·4

TABLE IX.—STEAM CONSUMPTION IN ENGINES WORKING WITH A VARIABLE LOAD.

	Average load factor.	Steam consumption in lbs. per average electrical h.p. hour.	Per cent. increase of steam consumption due to variable load.
I. 500 E.H.P. engine..	0·22	50	108
Ia. 500 E.H.P. engine and similar engine running at half speed.	0·19	67	180
II. 200 E.H.P. engines.	0·49	34·5	44
IIa. do. with one similar engine running at half speed.	0·36	42	75
III. 100 E.H.P. engine..	·65	29·5	23
IIIa. do. and one similar engine running at half speed.	·53	33·1	38

Increase of Steam Consumption working with a Variable Load.—Captain Sankey has applied Mr. Willans's formula to find the steam consumption of one or more engines working against a variable load, as in an electric lighting station. He takes a normal midwinter load curve and examines how the

necessary current could be supplied during the twenty-four hours (1) with one engine capable of exerting the maximum power required; (2) with smaller engines. He also considers the steam consumption when one additional engine is kept running at half speed as a stand-by in case of accident. The results re-arranged and a little modified are given in the preceding Table. It is assumed for convenience that the maximum load is 500 electrical horse-power, and that the engines are non-condensing.

Influence of Irregular Working of the Boilers on the Expenditure of Fuel.—With a varying load the steam consumption, and consequently the fuel consumption also, is increased (1) in consequence of the decreased mechanical efficiency of the engines with light loads; (2) by the greater proportion the work expended in overcoming back pressure bears to the total work of the steam; (3) by the diminished thermal efficiency of the engine. But all these causes taken together do not expiain fully the great fuel consumption in such cases as electric lighting stations. There is another very obvious cause of uneconomical working which cannot at present be estimated quantitatively for want of sufficient experimental investigation. With a very varying load, boilers must be put in steam and banked up alternatively, and the waste in getting up steam and allowing the boilers and brickwork to cool down again is no doubt considerable. This waste is at present unavoidable, except so far as means can be adopted to improve the load line.

Table X.—Coal Consumption in Boilers with a Variable Load.

	11 a.m. to 6 p.m. 7 hours.	6 p.m. to midnight. 6 hours.	Midnight to 11 a.m. 11 hours.	Mean for 24 hours.
Total I.H.P. hours	562	1,366	407	—
Total E.H.P. hours	400	979	260	—
Coal per I.H.P. hour	6·88	3·26	6·26	4·65
,, ,, E.H.P. ,,	9·67	4·55	9·80	6·62
Pounds of water evaporated per pound of coal	5·92	9·60	9·27	8·21
Pounds water per I.H.P. hour	40·7	31·3	57·7	38·3
,, ,, E.H.P. hour	57·2	43·8	91·0	54·4

Some tests, made by Prof. Kennedy at the Millbank-street Station of the Westminster Electric Supply Corporation, indicate pretty clearly a boiler waste additional to the engine waste. Dividing the day into three portions, he determined the fuel consumption, the feed-water evaporated, and the indicated and electric horse-power developed during each period. It will be seen that during the periods of light loading the fuel consumption per horse-power hour is very large.

Perhaps the fairest way of considering the waste due to variable load will be to compare the mean consumption in the twenty-four hours with the consumption between 6 p.m. and midnight, when the load was heaviest. It will be seen that the mean steam consumption per electrical horse-power hour was 24 per cent. greater than during the period of heavy load. But the mean consumption of coal per electrical horse-power hour was 46 per cent. greater than during the period of heavy load. The difference of 22 per cent. must be attributed to waste at the boilers, due to irregular working. During the whole 24 hours the mean evaporation, in pounds of water per pound of coal, was only 85 per cent. of the evaporation during the period of maximum load.

Variation of Efficiency and Fuel Consumption in Internal Furnace or Explosion Engines.—Gas and liquid fuel engines receive their charge at atmospheric pressure as well as exhausting into the atmosphere. Hence in a complete cycle the resultant back pressure loss is comparatively small. The engine friction however is rather larger than in steam-engines and appears to be independent of the load. Hence the mechanical efficiency decreases at light loads. Also at light loads the combustion is in some cases less perfect, or proceeds more slowly, and this is a cause of loss. It is well understood that gas and petroleum engines should be worked as far as possible at full

load. At the Dessau Electric Station, which is worked with gas-engines, large secondary batteries are used to store the surplus energy when not required for supply and to obviate the necessity of working the engines at light load. On the other hand, engines of this type have the very great advantage that they can be started in a few minutes when required and stopped whenever they are not wanted. There is in a station worked with such engines, no loss like that due to irregular working of the boilers.

TABLE XI.—FUEL CONSUMPTION IN INTERNAL FURNACE ENGINES.

Brake load in per cent. of load at full load.	Gas-engine. c. ft. of gas per brake h.p. hour.	Oil-engine. lbs. of oil per brake h.p. hour.
100	21·65	1·00
75	23·78	1·13
50	28·05	1·40
25	40·85	2·20
12½	66·45	3·80

It will be seen that the cost in fuel per horse-power increases greatly at light loads.

COST OF STEAM-POWER.

The probable cost of steam-power in any given case can only be determined by careful estimates in which local conditions are taken into account. The cost of coal, facilities for obtaining water, the cost of labour, even the type of engine and character of the buildings required, are more or less different in different cases. Certain typical cases may however be taken, and an average estimate made of the cost in such cases. The cases will be taken first of engines used in industry and working a regular number of hours daily with a nearly regular load. This will afford some indication as to how far motive power, supplied from central stations by some method of transmission, can be used economically in place of power generated locally by steam-engines. Then the special case of the cost of power generated by steam in central stations for distribution will be considered.

Cost of Engines, Boilers, and Buildings.—With engines of 100 horse-power or more, the cost can be pretty definitely stated, and the total cost of engines and boilers per horse-power does not vary very greatly with the type of engine adopted. For if a cheaper and simpler type of engine is selected, then, its efficiency being less, the boilers have to be larger; but, with small engines, the cost per horse-power increases very considerably, both because small engines are less efficient, and because they are more expensive to construct.

It will be assumed for the following estimates that the total cost, erected, of engines and boilers, with pipes and auxiliary apparatus, and such buildings as are necessary, may be taken to be as follows:—

TABLE XII.—COST OF STEAM PLANT.

Indicated H.P.	Cost per I.H.P. in £.	Effective H.P.	Cost per H.P. in £.
1	56	·7	80
10	30	7·5	40
50	24	40	30
200	20	165	25

In determining the annual cost, interest will be taken at 5 per cent., and maintenance (repairs) and depreciation at 7½ per cent.

Cost of Coal and Petty Stores.—In the following estimates coal will be taken at 20s. per ton. The amount of coal required must be calculated so as to allow for lighting up boiler furnaces; for waste due to cooling of boilers and brickwork when steam is let down; and for working auxiliary apparatus such as feed pumps.

TABLE XIII.—WORKING COST OF STEAM PLANT.

Indicated H.P.	Coal per I.H.P. hour.	Effective H.P.	Coal per Effective H.P. hour.
	lbs.		lbs.
1	8	·7	11½
10	5¼	7·5	7
50	2¾	40	3½
200	2·0	165	2¼

The cost of petty stores will be taken at 0·25 lbs. per effective horse-power per annum in the case of moderately large engines working 10 hours a day. In other cases a proportionate estimate will be made.

Cost of Labour.—For driving, stoking, and cleaning an allowance of £1·2 per annum per effective horse-power for 3,000 hours, or £0·6 per annum for 1,000 hours, will be made. In the case of engines of 10 horse-power or less, however, the labour reckoned on the horse-power costs considerably more.

TABLE XIV.—COST OF AN EFFECTIVE H.P. PER YEAR OF 1,000 WORKING HOURS. THE ENGINE WORKING REGULARLY WITH NEARLY FULL LOAD.

	Indicated h.p. of Engine.			
	1	10	50	200
	£	£	£	£
Interest, at 5 per cent., on engines, boilers, and buildings ...	4·00	2·00	1·50	1·25
Maintenance and depreciation at 7½ per cent.	8·00	3·00	2·25	1·88
Coal at 20s. per ton	5·13	3·12	1·56	1·01
Petty Stores	0·50	0·30	0·20	0·15
Labour	6·25	3·00	0·80	0·70
Total cost of one effective h.p. per year of 1,000 hours	23·88	11·42	6·31	4·99
Cost (in pence) per effective h.p. hour	5·75	2·84	1·51	1·20

TABLE XV.—COST OF AN EFFECTIVE H.P. PER YEAR OF 3,000 WORKING HOURS. THE ENGINE WORKING REGULARLY WITH NEARLY FULL LOAD.

	Indicated Horse-power.			
	1	10	50	200
	£	£	£	£
Interest at 5 per cent. on engines, boilers, and buildings	4·00	2·00	1·50	1·25
Maintenance and depreciation at 7½ per cent.	6·00	3·00	2·25	1·88
Coal at 20s. per ton	15·39	9·36	4·68	3·03
Petty Stores	0·75	0·45	0·30	0·25
Labour	12·50	6·00	1·50	1·20
Total cost of an effective h.p. per year of 3,000 working hours in pounds	38·64	20·71	10·23	7·61
Cost of an effective h.p. hour in pence	3·10	1·66	·82	·61

The results given in these Tables are plotted in Figures 8 and 9. The extremely rapid increase in the cost of working for small powers is very striking.

Annual Cost of an Effective Horse-power per Annum obtained by an Engine Working with Dowson Gas.—It will be useful to place alongside these estimates of the cost of a steam horse-power an estimate of the cost of a horse-power obtained from a gas-engine. For comparison, the very careful estimate of Prof. Witz may be taken, based on experimental trials of an engine of 112 indicated horse-power, or 77 effective horse-power, worked with Dowson gas. The total cost of the engine, with pump and pipes, was £944, or £8·2 per indicated horse-power. The gas generator cost £280, or £2·5 per indicated horse-power. Foundations and erection (without buildings) cost £68, or £0·61 per indicated horse-power. The total cost, without buildings, was, therefore, £11·5 per indi-

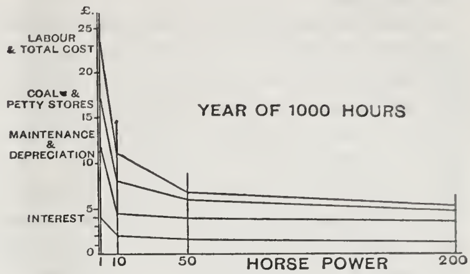


FIG. 8.

cated, or £17·2 per effective horse-power, a cost about equal to that of a steam-engine plant of the same power. Prof. Witz takes the cost of anthracite at 25s. a ton, and coke at 28s. a ton. He allows for interest and

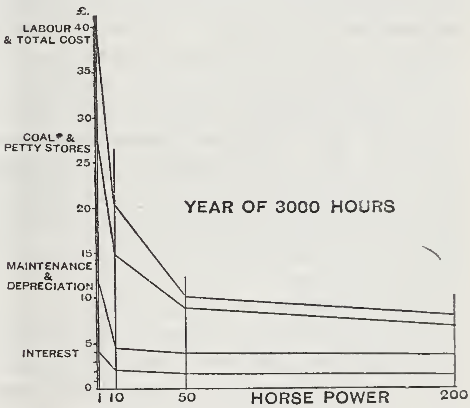


FIG. 9.

depreciation 15 per cent. The gas consumption is taken at 84 cubic feet per effective horse-power hour, which allows nothing for irregular working. Prof. Witz's figures are reduced to a year of 3,000 working hours.

TABLE XVI.—COST OF AN EFFECTIVE H.P. IN A GAS-ENGINE, USING DOWSON GAS, PER YEAR OF 3,000 WORKING HOURS.

	£
Interest and depreciation at 15 per cent. ..	2·78
Anthracite and coke	2·36
Petty stores	·40
Wages	·96
	6·50

The cost appears to be slightly less than that of a steam-engine of corresponding power. The cost is equivalent to 0·51 pence per effective horse-power hour.

Cost of Steam-power in Central Stations.—The case of a central station worked by steam-power differs from those previously considered in consequence of the excess of plant required, and the waste due to working against a varying load.

In such a generating station, whether supplying electricity or energy in any other form, it is usually necessary to work night and day. Part of the engines must work 8,760 hours in the year; but for a large fraction of the time much of the plant is standing idle. The demand for motive power purposes is greatest during the day hours, that for lighting during the evening hours; during part of the night the demand for any purpose is very small. It follows that the plant required must be much larger than that which would be required to meet the average demand if that could be supplied uniformly during the 24 hours. Further, there must be a reserve of power, so that any engine or boiler can be laid aside for examination or repair without hindering the work of the station. That reserve will be taken to be 25 per cent. of the whole power.

The earning power of the plant depends on the average demand and average rate of working. The coal and labour depend on this also, but are increased in consequence of the uneconomical conditions of working. The interest and depreciation must be calculated on the maximum output of which the plant is capable.

Working Cost of Engines Reckoned also at per Indicated Horse-power at Full Load.—The cost of coal will be taken at 7s. per ton. The cost of oil and petty stores will be taken at £0·28 per indicated horse-power per year. Labour is a difficult item to estimate, because it depends so much on management and conditions of working. The cost of labour will be taken at £2 per indicated horse-power. The following rates will be assumed for interest and depreciation :—

	Per cent.
Interest on capital cost of plant....	4
Maintenance and depreciation :—	
Buildings	2
Machinery	$7\frac{1}{2}$

From what has been said, it will be seen that the annual cost of a horse-power depends on the distribution throughout the day of the work to be done. If the work is regular, and the engine works at nearly full load, the cost of the horse-power is comparatively small; on the other hand, if the work is very irregular, larger engines are required, the working is inefficient, and the cost is comparatively large.

Two limiting cases will be considered :—

Case I.—Conditions similar to those of an engine pumping to reservoirs night and day all the year round. Such an engine may be taken to work 90 per cent. of the whole year, or of 7,884 hours in the year. For one effective horse-power of work done there must be exerted 1/0·85 = 1·176 indicated horse-power, allowing for engine friction. And for every 1·176 indicated horse-power, engines of 1·47 indicated horse-power must be provided to allow the necessary reserve.

Case II.—Engines working in conditions similar to those of an electric lighting station. The engines work all through the year, but the maximum demand is four times the average demand. For every effective horse-power the engines must exert (neglecting the variation of mechanical efficiency) 1·176 indicated horse-power, and for every 1·176 indicated horse-power of average demand there must be provided engines capable of exerting 4·70 indicated horse-power during hours of maximum demand. Further, to allow a reserve, the engine power in the station must be 5·87 indicated horse-power for every effective horse-power of average demand.

Case I. — Engine working on a very regular load, in conditions similar to those of an Engine pumping to a Reservoir.— Here, for one effective horse-power exerted during 7,884 hours annually, engines of 1·47 indicated horse-power must be provided. Such engines may be taken to use 14 lbs. of steam per indicated horse-power in test trials. But in ordinary work, $7\frac{1}{2}$ per cent. more must be allowed for leakage, working auxiliary engines, and less careful attention. This makes the consumption 15 lbs. of steam per indicated horse-power, or 15 × 1·176 = 18 lbs. per effective horse-power hour. At 9 lbs. of steam per pound of coal, allowing also 5 per cent. for lighting and banking fires, the engine would use 2·1 lbs. of coal per effective horse-power hour. There are very few engines working with quite so low a consumption.

Cost of Installation.

Cost of engines for 1 effective horse-power or with reserve 1·47 indicated horse-power = 1·47 × 8·9	£13·3
Cost of boilers = 1·47 × 4·8	7·0
Cost of buildings 1·47 × 6·0	8·8
Total............	£29·1

Annual Cost of Working per Effective Horse-power.

Interest at 4 per cent.	£1·164
Maintenance and depreciation:—	
Buildings, at 2 per cent.	0·176
Machinery, at 7½ per cent.	1·522
Total fixed annual cost	2·862
Coal, 2·1 lbs. for 7,884 hours, at 7s. per ton	2·587
Petty stores	0·327
Driving, stoking, and cleaning	2·334
Total annual cost.	£8·110

This is equivalent to 0·24 pence per effective horse-power hour.

Case II.—Engines working with very variable load, in conditions similar to those of an Electric Lighting Station.—Here, for one effective horse-power supplied, on the average throughout the year, engines of 5·87 indicated horse-power have to be provided. On account of the inefficiency and waste due to the variation of the load, it is best to estimate the steam and coal from experience in similar cases. Probably, no electric lighting station at present works with quite so low a consumption as 6 lbs. of coal per hour per electrical unit supplied. A consumption of 9 lbs. is probably much more common in the best managed stations. Six pounds of coal per electrical unit corresponds to 3·8 lbs. per effective horse-power hour.

Cost of Installation.

Cost of engines for one average effective horse-power, with reserve 5·87 indicated horse-power = 5·87 × 8·9	£52·2
Cost of boilers = 5·87 × 4·8	28·5
Cost of buildings = 5·87 × 6·0	35·2
Total cost	£115·9

Annual Cost of Working per Effective Horse-power.

Interest at 4 per cent.	£4·64
Maintenance and depreciation:—	
Machinery, at 7½ per cent.	6·05
Buildings, at 2 per cent.	0·70
Total fixed annual cost	11·39
Coal, 3·8 lbs. for 8,760 hours at 7s. per ton	5·20
Petty stores	0·33
Driving, stoking, and cleaning	2·33
Total annual cost	£19·25

This is equivalent to 0·51 pence per effective horse-power exerted on the average throughout the year.

Cost of a Horse-power at existing Electric Lighting Stations. — It is, perhaps, not entirely fair to take the cost of working of electric lighting stations as a guide to the cost of steam-power. They have been recently established; they work under difficult conditions, and the best methods of economising cost have probably not yet been arrived at. On the other hand, they are central stations of the kind discussed in these lectures, and accounts of the cost of working are published in returns made to the Board of Trade.

To be as fair as possible to electrical engineers, the case of Bradford may be taken, where, according to the returns, a unit of electricity supplied is generated more cheaply than at any other station. In dealing with the figures in the returns, the cost under the heading, "Salaries of manager, engineer, &c.," and that under the heading, "Redemption fund," are discarded. Further, half the cost under the headings, "Depreciation" and "Repairs and maintenance," is also subtracted, because under these headings are included charges not belonging to the cost of generating power. It would not make much difference if a larger or smaller fraction had been subtracted. After making these deductions, the cost of a unit of electricity supplied at Bradford mainly, if not entirely, attributable to the cost of producing power is 2·1d. Now the mechanical value of an electric unit is 1·34 horse-power hours. Taking the average efficiency of the dynamo at 0·85, then one unit corresponds to 1·34/0·85 = 1·57 effective horse-power of the engine. Calculated on this basis it appears that the cost of an effective horse-power per year of 8,760 hours, at Bradford, is £49. The cost of coal and petty stores alone, exclusive of all charges for labour interest and depreciation is £14·6. At most other stations for which returns are made, the cost reckoned in the same way is considerably greater.

Miscellaneous.

TECHNICAL INSTRUCTION IN GREAT BRITAIN.

From a Parliamentary paper just issued, it appears that, of the 49 counties in England, 42 apply the whole amount of the residue received under the Local Taxation (Customs and Excise) Act, 1890, to technical education, and the remaining seven apply a part of the residue. Of the 61 county boroughs, 47 apply the whole, and 10 part of the residue. Great Grimsby has not decided, and no returns have been received from Portsmouth, West Bromwich, and Ipswich, but, it is believed, that these three

boroughs devote the whole of the residue to technical education. Eight boroughs levy a rate, or make grants out of the rates under the Technical Instruction Act, 1889. Of the 13 counties in Wales (including Monmouth, to which the Welsh Intermediate Act, 1889, applies), 12 apply the whole, and one a part of the residue, under the Welsh Intermediate Act. Six counties levy a rate, or make grants out of the rates, under the Technical Instruction Act, 1889; and all 13 levy a rate under the Welsh Intermediate Education Act, 1889. The three county boroughs all apply the whole of the residue to technical education under the Welsh Intermediate Education Act, 1889, and levy a rate under the same Act; and one borough also levies a rate, or makes grants out of the rates under the Technical Instruction Act, 1889. Of the 33 counties in Scotland, 20 apply the whole of the residue to technical education, six apply a part, four are considering the question, and two apply the whole of the residue to the relief of the rates. No return was received from Ross and Cromarty. Of 82 burghs, seven apply the whole to technical instruction, 21 a part, one was considering the question, 51 apply the whole residue to relief of the rates, and two made no returns. Of 105 police burghs, 9 apply the whole to technical instruction, 18 a part, 9 were considering, and 66 apply the whole to the relief of rates. The following is a general summary of the reports:—

"The operations of the county and county borough councils in England and Wales are, in many cases, carried out by technical education committees, to whom the councils have delegated their powers (except the power of raising a rate or borrowing money) under subsection 1 (2) of the Technical Instruction Act, 1889; and organising secretaries, or directors of technical education have been appointed in the great majority of counties, and in some of the county boroughs. Several of the County Councils (Cheshire, Stafford, &c.) have, evidently with a view to stimulate local effort, made grants to urban sanitary authorities, on condition that the latter levy a rate, or contribute a sum out of the rates, under the Tehcnical Instruction Act, 1889, or provide funds from other local sources to supplement such grants. A noticeable feature with regard to the work of the county boroughs is, that many of the councils have either erected, or decided to erect, technical schools, or have taken over existing schools, for the purpose of supplying technical instruction under their direct control, to which they have decided to apply the whole of the funds at their disposal, which, in some cases, include the proceeds of a rate levied under the Act of 1889.

"As regards Wales (including Monmouth), the larger proportion of the residue is devoted to intermediate and technical education under the Welsh Intermediate Education Act, 1889. The schemes of the joint education committees under that Act also provide for the levying of a rate of ½d. in the pound in the case of each of the 13 counties and three county boroughs. Further, several of the councils raise a rate, or make contributions out of the rates, under the Technical Instruction Act, 1889. As instances of the extent to which funds are being devoted to educational purposes it will be observed that the Glamorganshire County Council devote the whole of the residue to intermediate and technical education, and levy a rate of ½d. in the pound under the Welsh Act, besides a rate of 1d. in the pound (producing about £9,500 per annum) under the Technical Instruction Act, 1889, while in the case of Monmouth one-half of the residue, together with the proceeds of a rate of ½d. in the pound (about £1,783 per annum), is applied to technical education, and the remaining half of the residue to intermediate and technical education, in addition to which it is intended to levy a rate of ½d. in the pound under the Welsh Act. The council of Cardiff county borough allocate the residue in equal parts for the purposes of intermediate and technical education respectively, and, in addition, levy a rate of ½d. in the pound under the Welsh Act, and a rate of 1d. in the pound (producing £3,106 per annum) under the Technical Instruction Act, 1889.

"It appears from the returns that the promotion of technical instruction in Scotland is progressing, though slowly. Technical education committees have been formed, particularly in the counties; and in one case (the county of Aberdeen) an organising secretary has been appointed to arrange and supervise the instruction. Most of the county councils devote the whole or part of the residue to the purposes of technical education, but the majority of the burghs still apply the money to the relief of rates."

MANUFACTURE OF WOOD PULP IN GERMANY.

The United States Consul-General at Frankfort, in his last report, says that nothing can more forcibly illustrate the supremacy of the German people in all that relates to the application of chemistry to practical manufacture, than the enormous development of the wood pulp industry in that country during the last ten years. The development is the more remarkable because it has been achieved in the face of several serious disadvantages, with which the pulp makers of neighbouring countries — particularly Norway and Austria—have to contend. In Scandinavia and the Austrian Empire the forests are of vast extent, and mainly native growth, whereas in Germany they are largely artificial, and planted and grown under Government supervision. Wood is, therefore, nearly twice as costly as in the other countries named, labour, coal, and railway freights are higher, while water power and interior water transportation are comparatively limited. Notwithstanding all these difficulties, the German chemical pulp industry has developed until its annual production is now 15,000 tons, of which one-third is exported, and the remainder consumed in the

country. Ten years ago most of the wood pulp produced in Germany was manufactured by the soda process; since then the superiority of the sulphite method has been so obvious, that the product of 1892 included only 12,500 tons of soda pulp, the remaining 137,500 tons being produced by the sulphite process. The Mitscherlich sulphite process, as practised at Okriftel, Aschaffenburg, and other places in the district of Frankfort, may be described as follows:—The wood used is pine, mainly of the variety known in Germany as *tannenholz*, which grows straight and slender in the densely-planted forests, the supply from the Frankfort region coming from the Black Forest and the Oldenwald. The trees when cut in the latter forest are from eight to twelve inches in diameter, and have few or no branches except near the top. They are carefully selected, felled and cut into lengths of about eight feet, the bark shaved off, and knots and other blemishes removed by hewing or boring. The selection and preparation of the timber for pulp-making is a most important part of its business, the workmen assigned to that duty being among the most intelligent and liberally paid of all occupied in the manufacture. Thus prepared, the sticks are brought to the factory and passed one by one through a machine armed with a powerful revolving knife, which at each revolution slices obliquely through the log, cutting off a chip about three inches in length, which is split by impact of the knife into shreds varying from mere splinters to two or three inches in thickness. From the cutting machine the chips are carried to the boilers which, in the Mitscherlich process, are made large enough to contain not less than ten tons of wood. Such a boiler is from 30 to 40 feet in length, and 12 to 14 feet in diameter, and is set either vertically or horizontally in strong masonry. The boiler is pierced with manholes for introducing and removing the wood, and is fitted with a system of branching pipes, controlled by valves and leading to the steam generator, the water reservoir, and the tanks where the chemical solution is stored after preparation by one of two processes to be afterwards described. Gauges and cocks are also provided to enable the attendant to read and regulate the pressure in the boiler and to draw off samples of the liquid contents, from which the progress of the operation can be accurately observed. The treatment of the wood in the boiler includes two stages or operations—digesting and boiling—the first being performed with live steam and spent bisulphite solution, the second with fresh bisulphite and steam heat applied through coils of hardened lead pipe laid round the lower portion of the interior to about one-third the height of the boiler, the proportion being about 50 square feet of heating surface to each 1,000 feet of its capacity. As sulphurous acids attack iron and steel, it was found necessary to make these steam coils of lead, and to protect the interior of the boiler with a lining of acid-resisting material. For the latter purpose lead was at first used, but an improvement was afterwards made in the substitution of hard, glazed earthenware tiles or bricks firmly laid against a backing of sheet-lead closely packed between the tiles and the steel shell of the boiler. These lining bricks are made with edges tongued and grooved, and the lining when properly made, lasts a long time, and thoroughly protects the shell, the point of greatest danger being the edges of the upper manholes, which are exposed to the action of sulphurous gases, rather than liquid solutions. The boiler having been filled with water, and the manholes securely closed, steam is turned in from the generator, and at the same time there is introduced, through a pipe at the bottom, waste or spent solution of bisulphite of lime. As the pressure increases, the steam penetrates the pores of the wood, expelling the air, and opening the way for the chemical solution which gradually rises, submerging and penetrating the wood, and replacing the steam attacking in proportion to the strength of the lye the resinous matter in which the fibre is imbedded. This steaming and softening process, technically called "digesting," occupies from eight to ten hours. When it is finished, the steam is shut off, the lye withdrawn, and the fresh solution of strong bisulphite of lime turned in. The cold injection condenses the steam, producing a vacuum, which sucks the solution upward without the aid of pumping until the requisite quantity has been injected. The valve is then closed, and steam turned into the coils, and the second operation, "boiling," begins. This commences gradually as the temperature rises, and continues from 18 to 20 hours. This gradual raising of the temperature by the heat of the steam coils is a very important part of the process, and is conducted with great care. At about 158° Fahr. the chemical action of the bisulphite upon the resinous incrusting matter begins. At 212° steam begins to generate, and the pressure forces the liquid sulphite into the innermost pores of the wood. If the heating has been properly regulated, the pressure at the end of 36 hours will have risen from 45 to 50 lbs. to the square inch, and this is regarded as the proper limit. If the pressure shows a tendency to exceed this, the heat is shut off and a valve opened, which permits the sulphurous gases to escape into the sulphite tank, where they are condensed and the chemical principle saved. During the whole process of boiling, samples of the liquid are withdrawn from the boiler and tested, so that the attendant keeps exact account of the progress of the chemical action going on within. These tests are made by mixing in a test tube a known quantity of the bisulphite liquid with a certain proportion of ammonia, and noting the quantity of normal sulphite of lime that is precipitated. When the boiling is finished, the valve leading to the sulphite tank is opened, and the gases withdrawn and condensed therein until the pressure is reduced to nearly the atmospheric limit, when the waste sulphite or lye is drawn off from the bottom of the boiler to be used in the digesting stage of the

next charge. The manholes are then opened and a flood of water poured in, which washes the softened pulpy wood out into receiving tanks, where it is washed and stirred in fresh water until the free sulphite is eliminated. Thence it is passed in a stream of water under a number of stamps—similar to a quartz stamp—which macerates it to a coarse white pulp, and passes on through a series of rotary mixers, and, in the manufacture of cellulose, is run out in an endless web, like ordinary paper. This is about the thickness of medium pasteboard, and is either cut into sheets or wound into rolls of about a hundredweight for packing. When exported as pulp, it is air-dried and packed in bales of about 200 lbs. in weight.

General Notes.

Art and Industrial Exhibition.—At Bristol, on the 28th ult., an Art and Industrial Exhibition was opened. The exhibition, says the *Times*, was primarily started in order to give the public an opportunity of seeing what is done in connection with local industries, but it is intended to devote any profit made from it to the funds of several medical charities in the city. The promoters were fortunate in securing an admirable site in the centre of the city on a large space by the harbour, and on this an exhibition building has been erected. Two-thirds of the premises have been devoted to industrial exhibits and to machinery in motion. The other part of the building is for fine arts, of which there is an excellent display.

Madras Sugar Mills.—Except in Ganjam and South Canara, iron sugar mills—first introduced about 12 years ago—are making their way throughout the Madras Presidency. In Godavary, Bellary, the greater part of Coimbatore, and Trichinopoly, they have almost superseded the wooden mills of the country; in some cases, the ryots, who cannot afford to buy iron mills, hire them. The Collector of Kurnool suggests that iron mills should be exhibited at work in Cumbum during the sugar-cane season. The Collector of Coimbatore thinks that, if manufacturers take steps to bring their mills to notice, wooden mills would be driven out entirely. From one district it is reported that iron mills have not been introduced, owing to want of facilities for their repair.

Technical Education in London.—In November next the Technical Board of the London County Council will proceed to award not more than 200 minor scholarships, of which not more than 100 may be awarded to boys, and not more than 100 to girls. Candidates must be pupils of public elementary schools within the administrative county, must be under thirteen years of age on the first day of November, and at that date must have worked for at least one school year in the fifth or a higher standard, and have attended school with regularity during that period. Each scholarship will be awarded, in the first instance, for one year, and will be renewable for a second year if the scholar's conduct and progress are satisfactory to the Board. The scholarships will include free education at such suitable schools as the Board may hereafter approve, and a money payment of £8 during the first year's tenure of the scholarship, and £12 during the second year. The names of candidates must be sent to the Secretary of the Board by the head masters or mistresses of their respective schools not later than October 21st, and must, in each case, be accompanied by a recommendation from the managers of the schools certifying that the candidates' parents or guardians belong to the industrial classes, and may not reasonably be expected to be able to allow the candidate to continue at school without such aid as the scholarship is intended to provide. The selection of the candidates will be by examination of a simple character in subjects within the scope of pupils in the sixth standard. In the case of boys, special stress will be laid upon arithmetic. The Board is prepared, pending the consideration of other proposals for the development of technical education, to supply, during the session 1893-4, teachers of cookery and dressmaking in a limited number of selected centres within the Administrative County of London, where responsible committees have, or desire to have, classes in these subjects. The instruction given will be in plain cookery and dressmaking, of a character adapted to the circumstances of workmen's homes, and will be given in courses of 10 or more lessons of not less than 1½ hours each, and will consist, as a rule, of practice classes in addition to demonstration lessons. The number of pupils in a practice class must never exceed 15. Applications must be made by letter addressed to the Secretary of the Board, and should be sent in as soon as possible, and in any case not later than the 14th day of October. Evidence must be afforded to the satisfaction of the Board that the conditions of the Technical Instruction Acts are complied with. The Board is also prepared to receive applications from committees conducting evening science classes (not including either polytechnic or evening schools connected with the Education Department) within the Administrative County of London, during the session 1893-4 for aid towards making the instruction more practical and efficient. With regard to the provision of additional laboratories or their initial equipment, the Board will be prepared to consider any application for assistance by capital grants of a due proportion of the total cost, regard being had to the need for additional laboratory accommodation in the locality. The Board will also be prepared to consider applications for assistance by way of grant or loan towards the provision of suitable teaching apparatus approved by the Board's officers; but will not, unless in exceptional cases, provide, by way of capital grant, more than one-half of the initial cost of the apparatus.

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HOWARD LECTURES.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.

By Prof. W. Cawthorne Unwin, F.R.S.

Lecture II.—Delivered January 20, 1893.

The Storage of Energy and the Development of Energy by Water-power.

In most applications of the energy derived from fuel the fluctuation in the demand for power involves waste. But it is in steam central stations which have to work during 24 hours, during which the demand for power varies very irregularly, that the waste due to irregular working has been most serious. Of all central stations electrical central stations are those which have to meet the greatest fluctuation of demand for energy, and the waste so occasioned has compelled electrical engineers more than any others to seek for means of storing energy.

To completely meet a fluctuating demand by generators of energy worked at a uniform rate, there must be storage of energy satisfying two conditions. Twenty-four hours may be taken as the natural period of the fluctuation of demand for energy. In each 24 hours there will be two periods, one in which the demand falls below the average demand, and one in which the demand exceeds the average demand. The excess of energy supplied during one period will, on the average, be equal to the deficiency in the other period. If the generators are worked at a uniform rate, then all the energy supplied in excess of the mean demand in one period must be taken from storage, and must have been put into store during the period in which the demand fell below the mean demand. But this is not the only condition to be satisfied. With some kinds of storage, the rate at which energy can be taken out of store is unlimited. In other cases it is limited, and then the storage must be so arranged that the rate at which energy can be taken out of store is equal to the difference between the maximum rate at which energy is required and the mean rate.

Gas-holder Storage.—The distribution of gas is not strictly a distribution of energy, but only of the means of conveniently obtaining it. But a gas-lighting distribution is analogous to a distribution of energy, and the demand varies nearly as much as in an electrical distribution. The gas engineer is happy in having a convenient and cheap means of storage. Usually about 24 hours' supply of gas is stored in the gas-holders at a gas generating station. Hence the gas-making plant can be worked at an almost uniform rate day and night. Taking 25 cubic feet of gas as capable of yielding one effective horse-power hour of energy, it appears that gas-holders cost about 5s. 6d. per effective horse-power stored. Mr. Trewby puts the cost of gas-holders at a London station at £10,000 per million cubic feet of gas supplied per day. In that case such a station works virtually at 1,666 effective horse-power, and the cost of the gas-holders is £6 per effective h.p., reckoned on the average rate of supply throughout the year. Here allowing 10 per cent. for interest and depreciation, the storage adds about 12s. per effective horse-power to the annual cost.

Accumulator or Battery Storage.—The electrical engineer would be glad to have a means of storage equivalent to a gas-holder. For a time it was thought that such an equivalent had been found in the storage battery. The use of such batteries is limited to continuous current systems, and they have besides the practical defects—(1) that the maximum rate of discharge is limited, and (2) that about one-fifth of the energy stored is wasted. Nevertheless, they would have been an extremely important factor in electric central station working, but for their excessive cost. With a 24-hour load line, such as that of most electric lighting stations, the amount of storage required to enable the generators to work at a uniform rate may be defined thus:—The battery must be capable of supplying energy at a rate equal to three times the mean rate of supply for the 24 hours. Also, it must be capable of storing during one part of the 24 hours, and restoring in the other about half the whole supply for the 24 hours.

The cost of storage batteries prohibits their employment on this scale in large stations. Employed in a limited way, they serve some useful ends. In some stations they supply the

energy required for ten to thirteen hours out of the twenty-four, during which time the engines are stopped. They diminish the fluctuation of load of the engines during the time in which they are running, storing energy not required in the external circuit. But they do not obviate the necessity for having a varying number of engines at work. Prof. Kennedy puts the case well when he says that they enable the station to be shut down for some hours and act as fly-wheels, smoothing the irregularities of supply.

Cost of Accumulator Batteries.—From data given me by Prof. Ayrton, it appears that eight Epstein cells, tested in the laboratory, would work at 1 horse-power, and store a charge for $2\frac{1}{2}$ horse-power hours. The cells cost, without allowance for buildings, insulation, or switching arrangements, or for waste of energy, £20. That is, the bare cost of the cells amounts to £20 per horse-power reckoned on the maximum rate of working, or to £8 per horse-power hour stored. Suppose a station working at an average of 500 horse-power. The maximum demand in the 24 hours would be 2,000 horse-power, of which 1,500 would have to be supplied from the battery. The cost of the battery to supply energy at the necessary rate would be £30,000. During 24 hours the quantity of energy supplied would be 12,000 horse-power hours, half of which must be stored. Batteries of sufficient capacity would cost £48,000. Here the latter condition determines the cost. Taking interest at 5 per cent., and maintenance and depreciation at $12\frac{1}{2}$ per cent., the annual cost of the battery would be £8,400, or nearly £17 per horse-power of average rate of working of the station. This is the bare cost of the cells without buildings, adjuncts, or reserve.

In a project for lighting Frankfort-on-Main, Mr. Oskar von Miller and Mr. Lindley provided large secondary battery stations. The batteries had a capacity of 11,700 ampère hours, and were capable of supplying a current of 3,500 ampères at 100 volts. The batteries, with wood platforms, insulation, &c., were taken to cost £25,100, and the buildings for them £11,600. This is equivalent to a capital cost of £23 per horse-powet hour of storage capacity, or £78 per horse-power power reckoned on the maximum rate working.

Thermal Storage.—Secondary batteries, being too costly as a means of storage, except on a very limited scale, the question arises, is any other means of storage available in conjunction with steam-engines? Some means of hydraulic storage will be considered later; such means are rarely applicable for the storage of steam-power. Lately, Mr. Druitt Halpin has proposed a system of thermal storage, which appears, in many respects, to meet the conditions required.

Energy is first obtained in steam-power stations in the form of heat. Can the heat be directly stored? Heat is a very unprisonable form of energy, escaping through all bodies and in all directions. But, in New York, steam is transmitted through miles of pipes, and, by reasonable jacketing, the loss of heat is reducing to a moderate per-centage of that carried. In a properly constructed storehouse for heat with reservoirs, closely packed and presenting little external surface, the radiation loss need not be large.

For storage, heat must be imparted to a material body of large heat capacity. It is easily given to water in boilers of ordinary construction. A body of water, highly heated, in a well-insulated chamber, will store a large quantity of heat. To permit the water to be heated it must be kept under the pressure corresponding to its temperature. The task of storing a mass of heated water presents no mechanical or physical difficulty.

It is a condition of any system of heat storage for central stations that the energy stored should be recoverable whenever and at any rate of supply required. Heated water fulfils the condition. If the pressure is reduced steam is generated instantly and in controllable amount. The steam generated can be used in the engines to generate mechanical energy as it is wanted.

Mr. Halpin's plan is, therefore, to communicate heat in boilers to a body of water. The heated water is stored in reservoirs under pressure. From the reservoirs steam is taken through a pressure - reducing valve exactly when and in what quantity it is required. Mr. Halpin proposes that the heat reservoirs should be under a pressure of 265 lbs. per square inch (absolute) when fully charged, the corresponding temperature being 406° Fahr. He proposes that the steam-engines should be worked at 130 lbs. per square inch, corresponding to 347° Fahr. The total heat stored when the reservoirs are fully charged is the difference of the total heat of the water at 406° and 347° Fahr., or the heat due to a range of temperature of 59° Every pound of water falling in temperature through that range will yield 61 thermal units of heat. But the total heat required to generate a pound of steam at

130 lbs. per square inch from water at 347° is 868·8 thermal units. Consequently $14\frac{1}{4}$ lbs. of water falling in temperature from 407° to 347° will yield a pound of steam. To allow for radiation, loss, and imperfect working, this may be taken at 16 lbs. of water per pound of steam. A simple cylindrical reservoir, 8 feet in diameter and 30 feet long, will contain 84,000 lbs. of heated water. Such a reservoir would be capable of generating, under the conditions supposed, 5,250 lbs. of steam at 130 lbs. per square inch.

The steam consumption may be taken to be, per effective horse-power, 18 lbs. per hour in condensing, and 25 lbs. in non-condensing engines. Hence one such reservoir would store 286 effective horse-power hours if the steam is used in condensing engines, or 210 effective horse-power hours if the steam is used in non-condensing engines.

If the reservoir were fully charged and discharged daily, it would yield 104,400 and 76,660 effective horse-power hours of stored energy yearly in the two cases.

A reservoir, 30 feet by 8 feet, would cost, erected, with ample allowance for buildings and appendages, £470. As it is not exposed to fire, its deterioration would not be considerable, and 10 per cent. would be sufficient to cover interest, maintenance, and depreciation. Hence, the first cost of such reservoirs, reckoned on their storage capacity, and the annual cost per h.-p. added to stored energy by the cost of storage, would be as follows :—

	Cost of Reservoirs per Effective H.P. hour of Storage Capacity.	Annual cost of Storage per H.P. supplied from Reservoirs.
	£	£
Condensing plant....	1·64	3·94
Non-condensing plant	2·24	5·37

The cost in the last column is the cost due to 8,760 effective horse-power hours annually.

Mr. Halpin's plans appear to be practicable and to promise considerable economy in stations where the load fluctuates greatly, but they are untried, and it would not be fair to omit to point out that there are details of working involving difficulties which must be met.

The cost on the mean annual horse-power supplied is not inconsiderable, but it is not prohibitive. The waste in irregularly working stations is so large that *prima-facie* it may be assumed that there is economy in storage on Mr. Halpin's system. But it must be remembered that this system attacks the boiler waste only and leaves the engine waste due to varying load untouched. To a certain extent the latter losses can be mitigated by the subdivision of the engines.

Arrangement of Thermal Storage Reservoirs on Mr. Halpin's Plan.—It is possible that the best way of working thermal storage tanks is not yet known, but one arrangement proposed is shown in Fig. 10. The steam boiler *a* is completely filled with water, the storage tank *b* nearly so. The two are in free communication by a system of circulating pipes. There is an ordinary feed pump supplying water direct to the boiler or the storage tank. But instead of keeping the water in the boiler at a nearly constant level, the level in the storage tank is kept nearly constant. In addition there is a circulating pump maintaining a rapid current of water from the boiler to the storage tank, and, consequently, back from the storage tank to the boiler. Water heated in the boiler is constantly being sent to the storage tank, and water cooled by disengagement of steam is returning to the boiler. The steam spaces of the tanks are all in communication. The pressure there will be the steam pressure due to the hottest tank. The steam required is taken off through a reducing valve. It will then be generally dry, or slightly superheated, in consequence of wiredrawing, which is advantageous for the efficiency of the engines.

In a station with thermal storage tanks, the boilers will be of a size sufficient to supply the mean demand for steam on the day during the year when the demand is greatest. The boilers will be worked continuously at a nearly uniform rate, like a bank of gas retorts. The heat not required in hours of small demand will be stored in the tanks. The excess of heat required to generate steam in hours of great demand will be taken from the store in the tanks.

Example of a Station worked in the ordinary way and with Thermal Storage Tanks.—The example in Fig. 10 has been worked out by Mr. Halpin. He takes a case of an electric lighting station where with the normal midwinter load the daily output is 15,600 effective horse-power hours, or the mean rate of working 650 effective horse-power.

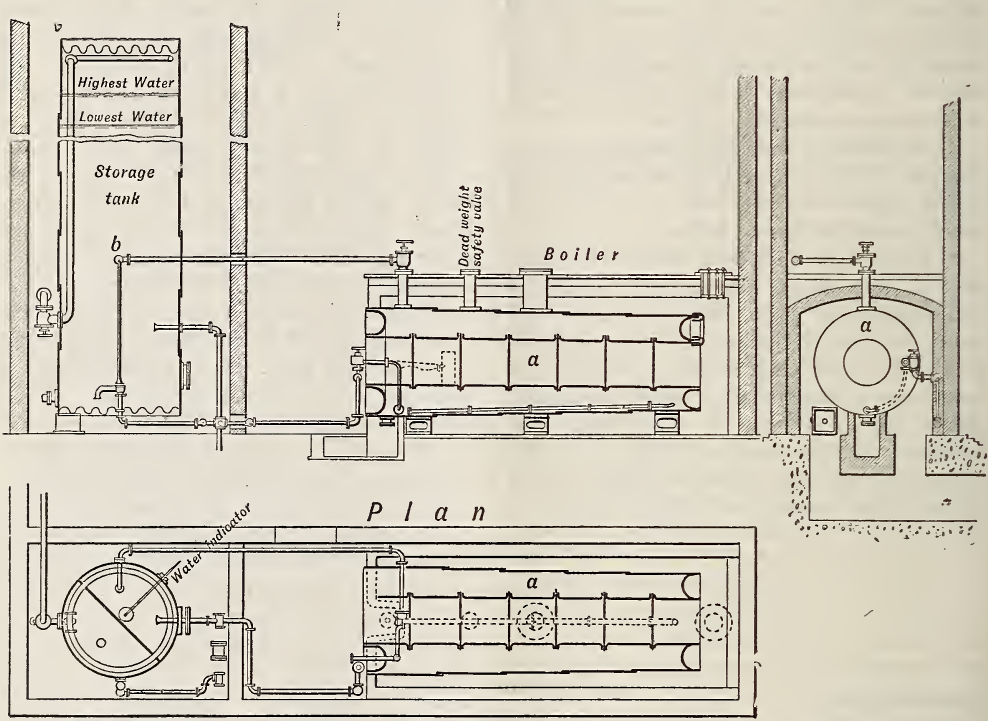
In ordinary conditions, without storage, engines and boilers capable of working to 2,400 horse-power, would be required during the short period of maximum demand. With thermal storage tanks the boilers would be of 650 horse-power only, but, on the other hand,

thermal storage tanks must be provided, capable of generating all the steam required in excess of 650 horse-power when the demand exceeds that amount. An examination of the load curve shows that 5,900 effective horse-power hours would meet the whole demand in excess of the mean demand. Taking 16 lbs. of heated water to supply 1 lb. of steam, 360 lbs. of water stored would generate steam enough for an effective h.p. hour. Then the storage tanks must contain 900 tons of water; 24 tanks 30 ft. by 8 ft. would have sufficient capacity.

Without storage tanks. Eight boilers, each with 2,000 square feet of heating surface and two boilers in reserve. Cost of ten boilers, with erection, pipes, and pumps, £10,300.

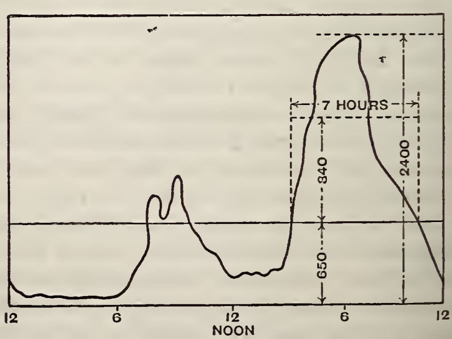
With storage tanks. Two similar boilers and one in reserve, and 24 thermal storage tanks. Cost of three boilers and 24 tanks, with erection, pipes, pumps, &c., £15,000.

The cost of the plant is greater with the storage tanks by £4,700. Taking interest and depreciation at 10 per cent., this would correspond to an annual charge of £470, or about the value of 470 tons of coal at London price. But if the saving of waste by having boilers regularly, instead of irregularly, worked were only ½ lb. per effective horse-power hour the annual saving of coal would be 1,270 tons.



THERMAL STORAGE BOILERS AND STORAGE TANKS.
FIG. 10.

Cases still more favourable for the application of the thermal storage system are those where heat is now absolutely thrown away. The destructor for ash-bin refuse, which has already been described, must be worked continuously day and night. This makes it difficult to utilise the heat. But with thermal storage tanks the heat might be captured and stored for use at hours when mechanical work had to be done. In such a case the advantage of thermal storage would seem to be very great. One other similar case has been thought of by Mr. Halpin. In the pro-



TYPICAL DIAGRAM. 2500 H.P. STATION
FIG. 11.

duction of lighting gas, about 312 lbs. of coke are burned per ton of coal carbonised. The heat in these products of combustion is now entirely thrown away. If they were taken through the flues of a boiler they might be reduced to 600° before escaping. They would furnish about 759 lbs. of steam per ton of coal carbonised, or about 25 effective h.p. hours.

Water-power.

Where there exists a natural waterfall, with a considerable and regular flow, and where local conditions are favourable for the construction of the necessary works, water-power is generally cheaper than steam-power. The water costs little or nothing; the cost of maintenance of hydraulic machinery, and the cost of superintendence are small; the power is regular, controllable, and convenient. In such cases, the annual cost of the power consists almost entirely of interest charges on the capital expended in works and machinery.

With some exceptions, water-power is at present utilised in the neighbourhood of a natural waterfall. The usual means of transferring the power of the fall adopted, till a recent period, has been the conveyance of the water itself in canals and pipes. In some cases water has been thus conveyed for hydraulic mining, and manufacturing purposes very considerable distances. But a more convenient and cheaper means of transmission would greatly increase the availability of water-power, and the relative importance of steam-power and water-power would, in some countries, be very considerably changed.

It appears, from a report by Mr. Weissenbach, that in 1876, 70,000 horse-power derived from waterfalls were applied in manufacturing in Switzerland. Probably the amount now employed is at least 80,000 horse-power. It is estimated that the total available water-power in Switzerland amounts to 582,000 horse-power. Putting the annual value of a horse-power at £6, this represents an annual value of £3,500,000. Used to replace steam-power, it would save annually 1,250,000 tons of coal. It is stated that at the present time Switzerland pays £800,000 annually to other countries for coal.* Nearly the whole of this expenditure could be saved if its natural wealth of water-power was utilised. The recognition of the importance of this supply of power is exciting great interest in Switzerland, and there is hardly an important factory which is not either using water-power or making preparations or surveys with a view of doing so.

* Reifer. Berechnung der Turbinen.

The utilisation of water-power often involves the construction of large permanent works, such as river dams, reservoirs, and canals. Mr. Emery estimates that at Lawrence, in the United States, £200,000 was spent on works, independent of the hydraulic machinery; and, at Lowell, a still larger sum.*

Such extensive works can be best executed by an association in the interest of many consumers. Thus is created a water-power company, who establish what is virtually a central water-power station and a distribution of power at a rental to consumers. In the American cases, as already stated, the water itself is distributed in canals to consumers at a level permitting the creation of a waterfall at the mill or factory. But in certain other cases a further step was taken: the water-power company utilised a natural fall and erected the necessary turbines, and then transmitted the power in the form of mechanical energy to consumers. Installations of such a kind, now of a quite respectable antiquity, were erected at Schaffhausen, Freiberg, Zurich, and Bellegarde. In these cases the means of transmitting power adopted, admirable as it was, had limitations and the extension of the works was restricted. Now that there are new means of transmission, the Schaffhausen and Zurich power generating stations are being increased, and a new and remarkable installation has been erected at Geneva.

The original project for utilising the motive power of the Rhone at Geneva, partly for pumping a supply of water, partly for motive power for industry, comprised 20 turbines of 300 horse-power each, or an aggregate of 6,000 horse-power. Fourteen of these were at work in 1892. Four more of somewhat larger size will, it is expected, be constructed by 1898. When these are at work, the whole available water-power in Geneva will be utilised. But it is foreseen that the demand for power will not then have been satisfied. The total receipts for the installation reached £22,500 in 1891, and were increasing £2,200 annually. The Municipality of Geneva has determined to provide for future demands, and plans are being studied for utilising 12,000 horse-power at a point on the Rhone six kilomètres below Geneva, whence the power will be distributed electrically. At Biberest, near

* "Cost of Steam-power." C. E. Emery. "Trans. Am. Soc. of Electrical Engineers," vol. x. p. 123.

Soleure, Messrs. Cuenod, Sautter, and Company have utilised 360 horse-power, and transmitted it 28 kilomètres electrically. At Genoa water-power due to surplus fall along a line of water main has been utilised at three stations. The greater part of the energy is transmitted to Genoa for electric lighting and power purposes.

These are cases where water-power has been utilised and distributed, which are actually in operation; but there are many other schemes projected: one is for utilising 10,000 horse-power on the Drause, near Martigny; another to utilise 20,000 horse-power at a point 17 kilometres above Lyons. In Sweden, there is a project to transmit power from the Dal River Fall, at Mansbo, to the Norberg mining district, a distance of 10 miles; another to transmit the power of the Strup Waterfall, on the Judal River, to the town of Ostersund, a distance of 11 miles. Projects for utilising the Falls of Trollhatan, and the River Motala to supply power to Gothenburg and Nord Koeping, have also been studied.

Water-power in the United States of America.—It is in the United States of America that water-power is most largely used, where it is in most direct competition with steam-power, and where data for a comparison of their relative advantages can best be obtained. Interesting data as to the extent to which water-power is utilised in the United States are given in a paper by Mr. G. F. Swain, read before the American Statistical Association.*

The money value of the water-power utilised in the United States is very considerable. From the returns of the Tenth Census it appears that in 1880 there were 55,000 water-wheels and turbines of an aggregate of 1,250,000 h.p. At £5 per per annum the water-power utilised is worth £6,250,000 a year.

The comparison of the relative amount of water and steam-power is interesting. Taking the whole of the United States, 36 per cent. of the power used in manufacturing was at that date water-power, and 64 per cent. steam-power. In certain industries the proportion of water-power was greater. In the manufacture of cotton and woollen goods, of paper, and of flour, 760,000 horse-power derived from water, and 515,000 horse-power derived from steam, were employed. In the North Atlantic division 4·81 water h.p. are utilised per square mile.

* "Statistics of Water-power Employed in Manufacturing in the United States." By G. F. Swain. Publications of the American Statistical Association, March, 1888.

Division.	Water Power Per Cent.	Steam Power Per Cent.
N. Atlantic	43·1	56·9
S. Atlantic............	49·5	50·5
N. Central	22·2	77·8
S. Central	22·5	77·5
Western	35·3	64·7
The United States	35·9	64·1

Fig. 12 is a map taken from Mr. Swain's paper, which shows that over a considerable area of the United States the water-power used exceeds the steam-power. It should, however, be pointed out that in the decade 1870-80, during which the total power used increased 45 per cent., 9 per cent. of the increase was due to water-power and 91 per cent. to steam-power. It is possible that under the new conditions now obtaining the present decade will show a greater relative increase of water-power.

American Method of Distributing Water-power.—The method in which water-power is distributed in America to a number of consumers is almost peculiar to that country. A water-power company is formed, which undertakes the construction of the permanent works, such as a river dam, sluices, and distributing canals. In New England there are five water-power stations, where more than 10,000 horse-power is utilised during working hours, and thirteen stations where more than 2,000 horse-power is utilised. The water is distributed to mill owners, who construct the turbines and pay a rental to the water-power company proportional to the amount of water used. The earliest application of this system was at Paterson, New Jersey, where the Passaic river furnishes about 1,100 horse-power night and day.* At Lowell, Massachusetts, the utilisation of the water-power began in 1822. The Merrimac river has a fall of 35 ft., and furnishes, at the maximum, about 10,000 horse-power during the usual working hours. At Cohoes, in the State of New York, the Mohawk river has a fall of 105 feet. It could furnish about 14,000 horse-power during working hours, but is only partly utilised at present. At Manchester, New Hampshire, the Merrimac has a fall of 52 feet, and furnishes, at the minimum, about 10,000 horse-power during working hours. At Lawrence, Massachusetts, the Essex Company built a dam forming a fall of 28 feet, and obtaining a minimum power of

* J. B. Francis, "Trans. Am. Soc. of C.E.," vol. x., p. 189.

10,000 h.p. during working hours. At Holyoke, the Hadley Falls Company built a dam forming a fall of 60 feet, and rendering a power of 17,000 h.p. available during working hours.

To indicate the magnitude of some of these works, it may be stated that at Lawrence the masonry river dam is 900 feet long and 32 feet in height. The cost was £50,000. From this dam two canals extend down stream, one on each bank, and between these canals and the river are located the mills, occupying the entire river front. On the north side the mills extend for a distance of more than a mile. The cost of the canal on the north side, 5,330 ft. in length and 100 ft. in width at the upper end, was £50,000. The canal on the south side, 2,000 ft. in length and 60 ft. in width, cost £30,000.

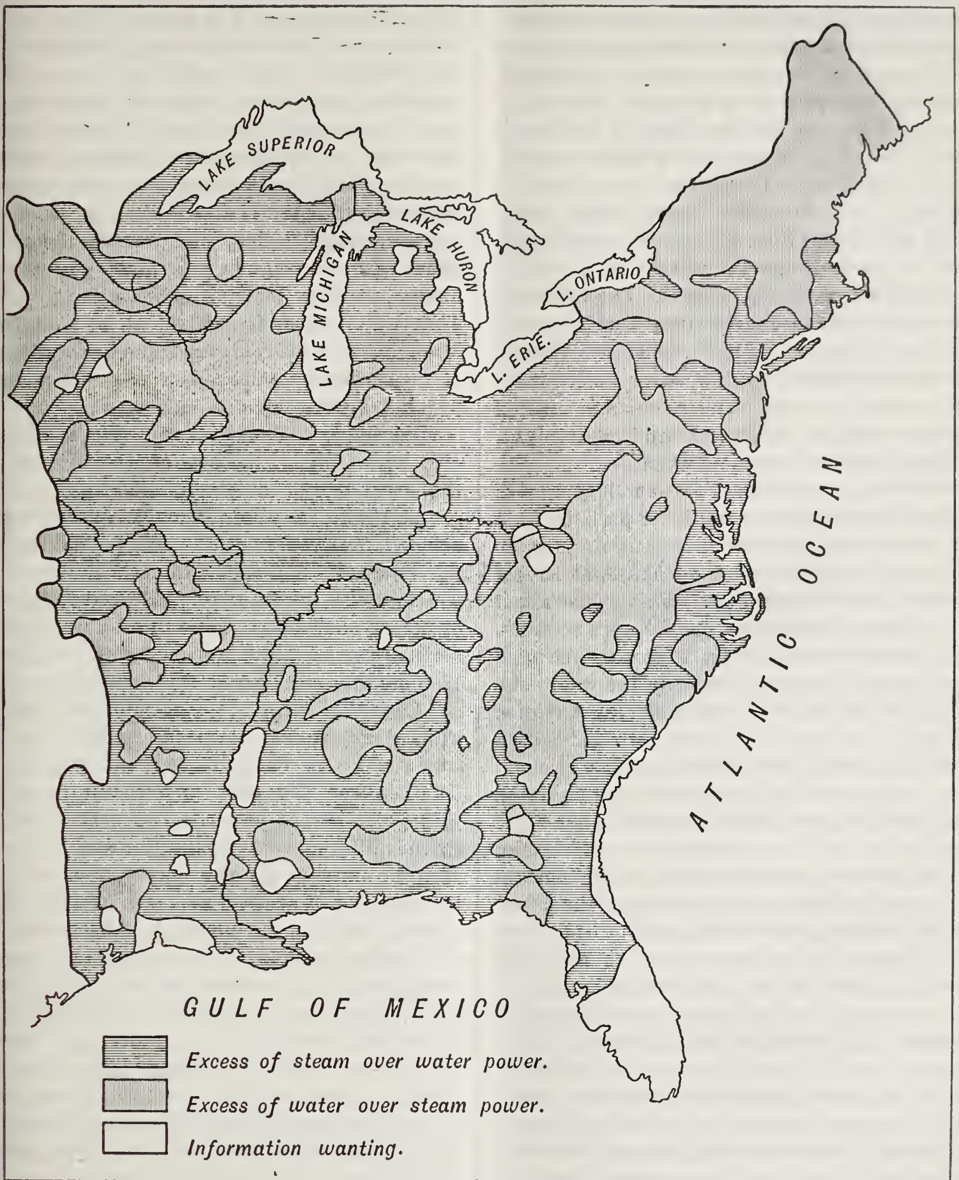


Fig. 12.

The case of Holyoke may be described in somewhat greater detail. The whole of the factories in the town are worked by water-power, and the system is strictly a distribution of power to many consumers at a rental strictly

proportional to the amount of power used, although the power is actually developed in the mills by turbines belonging to the mill-owners. The first weir or dam was built in 1847, but it was carried away. A second dam of cribwork was built in 1849. In 1868 an apron was constructed to protect the rock immediately below the dam; since then, Mr. Clemens Herschel* has carried out extensive repairs of the dam under conditions of singular difficulty and with great success. The structure is now 130 feet in width, 30 feet high, and 1,019 feet in length. From above the weir a first canal supplies water to the highest line of mills. From these mills, after driving turbines, the water is discharged into a second canal, which is a supply canal to a second line of mills. The tail races of these mills discharge into a third canal feeding a third line of mills, and there are still other mills worked by the water before it returns into the river. The power now utilised is 15,000 h.p. by day, and 8,000 h.p. at night. Altogether there are about 53 mills.

With the grant of land for a mill there was leased the right to use a definite portion of the water. A "mill power" is defined as 38 cubic feet of water per second on a fall of 20 feet during 16 hours per day. This gives about 63 effective horse-power on the turbine shaft. At the time when Mr. Herschel became engineer to the water company the water was used extravagantly. By introducing a system of testing the turbines, and by establishing gauges at each mill showing at any moment the amount of water passing through the turbines, great economy in the use of the water was secured. The water saved was sold for surplus power. Observations of the amount of water used by each turbine, and the difference of level in the head and tail-race are made once in the day and once at night. Three inspectors are engaged exclusively in this work. From the daily observations the amount of power used by each mill is calculated. A portion of the power is charged for according to the terms of the lease, at a fixed rental. The balance is charged for as surplus power. In times of very low water, the power is restricted to the amount guaranteed in the lease.

Relative Cost of Water and Steam-power in the United States.—In some cases local conditions are so favourable that water-power can be developed at an almost nominal cost. In other cases unforeseen contingencies have led to expenditures, which have made the cost of water-power excessive; greater, in fact, than that of steam-power. Mr. Swain puts the average cost of steam-power in the States, in favourable localities, at £4 per horse-power per annum, and that of water-power at about £2 per horse-power per annum. Both these estimates are so low that it may be suspected that they are based rather on the nominal power of the plants than on the average actual horse-power used throughout the year. The cost of water-power, however, varies greatly. Mr. Swain states that while in the North-West of the United States the cost for interest, depreciation, and water rental is about £2·2 to £2·5 per horse-power per annum, in New Jersey it is from £12 to £15. That water-power is used at all at a cost so large as this proves that it has advantages of convenience compared with steam-power, which balance some excess of cost.

It is somewhat difficult to arrive at a precise knowledge of the cost of water-power in the great works in America, because of the gradual way in which they have been developed, and the want of complete data as to the amount expended. Mr. C. E. Emery,* who is probably rather prepossessed in favour of steam-power, has made the following estimate of the cost of water-power at Lawrence. He puts the total cost of the structural works at Lawrence at £200,000, and the power utilised as equivalent to 13,000 horse-power for ten hours daily throughout the year. That makes the cost of structural works £15·4 per horse-power. The cost incurred by the mill-owners in erecting turbines, sluices, &c., he puts at £9 per horse-power of the turbines, or £13 per average horse-power, actually utilised, the turbines being generally constructed to yield surplus power in times of emergency. This makes the total expenditure £28·4 per average horse-power, utilised ten hours daily throughout the year. He allows 2½ per cent. for depreciation, 1¼ per cent. for repairs, 1¼ per cent. for taxes, 10 per cent. for interest, and 2 per cent. for working expenses, or, altogether, 17 per cent. on the capital expenditure. This makes the annual cost of a horse-power at Lawrence £4·7 per annum, which he takes to be about the same cost as that of steam-power with economical engines and coal at 8s. to 12s. a ton. No doubt, however, in many cases, water-power can be

* "On the work done for the Preservation of the Holyoke Dam, in 1885." By Clemens Herschel. "Trans. Am. Soc. Civil Engineers," vol. 15, p. 543.

* "The Cost of Steam-power." By C. E. Emery. "Trans. Am. Soc. of Electrical Engineers," March, 1893.

utilised at a less cost per horse-power than that incurred at Lawrence.

Cost of Water-power at Geneva.—It appears that at Geneva, for the first groups of turbines erected, of 840 horse-power, and for the river works then completed, the capital cost amounted to £60 per effective horse-power. The groups of turbines subsequently erected have cost only £19 per horse-power. The mean cost, when the present works are completed, will amount to £27 per effective horse-power. In this case the water costs nothing. If we allow 5 per cent. for depreciation, repairs, and working expenses, and 10 per cent. for interest on capital, the cost per horse-power per annum will only amount to £4. In the new works below Geneva, where 12,000 horse-power are to be utilised, it is estimated that the whole cost for turbines and structural works will amount to £60 per horse-power for the first 2,400 horse-power. When the whole installation is completed, the capital cost will be only £27 per horse-power.

Storage of Water-power.

The need of storing power derived from waterfalls arises out of different considerations from those which apply in the case of steam-power. A river flows day and night with an energy which varies according to the season but not from hour to hour. The work to be done necessarily varies in almost all cases, and in most cases there is no demand for work to be done during half the 24 hours. If no means of storage is found a large part of the natural supply of energy flows away and is wasted.

But there is another reason. In the case of water-power nearly the whole cost of the power is due to interest and depreciation on the permanent works, machinery and structures, nearly nothing is due to daily working expenses. With steam-power only about one-third or half the cost is due to permanent charges, and two-thirds to half arises out of wages and fuel. If the engine stops for 12 hours out of the 24, coal and wages are saved, and though the cost per horse-power is greater, it is only moderately increased. But if water-power machinery stops for 12 hours out of the 24, there is no sensible diminution of working expenses, and the cost per h.p. is doubled.

At some of the American water-power stations, an inducement is held out to consumers to work day and night, by charging a lower rate for power at night. In other cases the difficulty is met by storing the night water to be used by day, so that the amount of power which can be supplied during working hours is doubled. It will appear, in the course of these lectures, that one of the most characteristic advantages of water-power, as compared with steam-power, is that the former permits the storage of energy by means not costly or difficult. It is the facility of storing energy by raising water to elevated reservoirs which, in some cases, makes it profitable to pump water to be used afterwards for power purposes.

There are two distinct methods of storing energy in hydraulic systems, accumulation storage, and reservoir storage.

Perhaps, on superficial consideration, it would hardly have appeared likely that it could be profitable to pump water to be used for power purposes. There are cases where it is so: one of these is the system of hydraulic transmission originated by Lord Armstrong. The system of hydraulic transmission is used, and can only be used advantageously to work a great number of intermittently working machines. A single engine, working almost continuously, pumps water, which actuates a great number of intermittently working motors. Naturally, the fluctuation of demand for power varies a great deal, and storage is almost essentially necessary. Perhaps it is to the invention of the accumulator—a means of storing the energy of pressure water—that the success of the system of hydraulic transmission is chiefly due. The hydraulic accumulator is simply a vertical cylinder with a heavily loaded plunger, into which the water is pumped till it is required, and from which it is discharged by the descent of the plunger.

Let A be the area of the plunger in square feet, P the total load on it in lbs. Then $p = P/A$ is the pressure at which the water is delivered in lbs. per square foot. If h is the length of stroke of the accumulator plunger, then Ah is the greatest quantity of pressure water it will store, and $p\ Ah$ foot lbs. is the energy stored when it is fully charged.

The pressure used in systems of hydraulic transmission is generally 750 lbs. per square inch. Now one of the very large accumulators of the London Hydraulic Power Company has the following dimensions:—Diameter of plunger, 20 inches; stroke, 23 feet. At 750 lbs. per square inch, this accumulator, large as it is, stores only 2·4 horse-power hours—a comparatively insignificant quantity. The cost of this accumulator, reckoned on the capacity for storing energy, must be very large indeed. What makes the accumulator so important is that its rate of discharge is very

great. It would probably supply 100 horse-power for $1\frac{1}{2}$ minutes. Hence, like the fly-wheel, the use of the accumulator is limited by its costliness to meeting fluctuations of demand in short periods of time. It cannot be used to average the variations of demand through the 24 hours. It is superior to the secondary battery in that the rate of supply of stored energy is not limited.

If a suitable site can be found, reservoirs can be built of very, very large capacity at a cost not large per cubic unit stored. Let A be the mean area of the reservoir, h the variation of depth in the reservoir, and H the height of the reservoir above the hydraulic motors driven by the water (foot units). Then the volume in the reservoir when full is Ah, and the gross energy stored is—$GAh\,(H - \frac{1}{2}h)$ or $GAhH$ nearly.

At Zurich, for instance, the storage reservoir contains 353,000 cubic feet at an elevation of 475 feet above the motors. It, therefore, stores 5,284 horse-power hours.

At both Geneva and Zurich very remarkable and extensive systems for utilising and distributing water-power have been for some time in successful operation, and to these attention will be directed more than once in these lectures. In both cases the water flowing out of a large lake, with a comparatively small fall, is utilised to furnish a very considerable and valuable power. In both cases it has been found convenient and economical to use the low-pressure turbines to pump water to a reservoir at a great elevation and to use the pumped water for ordinary motor purposes.

Data may be taken from the Geneva installation, though the works in both cases are similar, and both have been financially successful.

At Geneva, the Rhone flowing out of Lake Leman has by skilful arrangements been made to afford a clear fall, varying from $5\frac{1}{2}$ to 12 ft.

At Geneva there have been erected on this fall—or shortly will be erected—18 low-pressure turbines, giving an aggregate power of over 4,000 horse-power. These turbines are used, primarily, in pumping a supply of water for Geneva; but, since 1871, there has grown up a system of using water from the town mains for motor purposes in Geneva; and it is an important secondary function of the low-pressure turbines to pump this water used for motor purposes. To begin with, it may be pointed out that low-pressure turbines, together with the building and permanent works required to create the fall, are very costly. It is desirable that, to reduce the permanent charges on the energy furnished, they should work as long hours as possible. Further, the total power furnished is even now insufficient for the work to be done, and it is necessary that water-power should not flow to waste; but, even for other reasons, it became necessary to use storage of energy before the present exigencies arose. In the earlier period of the enterprise to maintain constant pressure, in spite of the fluctuation of demand on the mains, it was necessary that the turbines should be constantly pumping in excess of the demand. The surplus was discharged through a relief valve, and involved a constant waste. To meet fluctuations of pressure, four large air-vessels were constructed, 5 feet in diameter, and 39 feet high. With these the working was smooth and successful, but necessarily wasteful.

When the electric installation was erected at Geneva, and driven by turbines actuated by the pumped water, the necessity of storage became more evident. At 4 kilomètres from Geneva, a site was found at an elevation of 390 feet above the lake, where a reservoir could be constructed. The reservoir contains 453,000 cubic feet, and stores, therefore, 5,573 gross horse-power hours of energy. Allowing for the loss at the motors driven by the water the effective energy stored may be taken at 4,180 horse-power hours. The reservoir is a covered reservoir of expensive construction. But its cost does not exceed £2·4 per horse-power hour of energy stored. It is a work requiring little maintenance, and it hardly adds 3s. per annum to the cost of a h.p. supplied. On the other hand, the energy stored would, without it, have gone to waste, and for this a rental is obtained of £8 per annum.

There is now in London an admirable system of hydraulic power distribution perfectly adapted to the special purposes to which it is applied, and mechanically and financially successful. But it is a system of limited applicability. Large as it is, the number of renters of power is under 2,000, and the maximum pumping capacity of the stations at present erected is 1,500 effective h.p.

In the comparatively small town of Geneva, with $\frac{1}{80}$th of the population of London, there is a system of power distribution as large and of more varied usefulness than the system in London. There were there, three years ago, 137 motors, aggregating 280 effective horse-power on the low-pressure mains, and 79 motors aggregating 1,284 h.p. on the high-pressure mains. The use of the hydraulic power was increasing at the rate of nearly 200 h.p. per

annum. Lastly, the power in Geneva is distributed to ordinary consumers at $\frac{1}{5}$th, and for the electric lighting at $\frac{1}{12}$th the London price.

Perhaps it is fair to add that in London there are 2,500 gas-engines, which represent a considerable aggregate power, virtually supplied from a central station. Nevertheless motive power is more generally, and more cheaply, distributed in Geneva than in London. No doubt local conditions have favoured the adoption of plans for distributing power in Geneva; but, perhaps, it has not yet been fully recognised in London what an advantage cheaply distributed power is. Perhaps, when this is better recognised, means may be found to make motive power more available as a purchasable commodity.

Miscellaneous.

THE BRITISH MUSEUM.

From a report just presented to Parliament, it appears that there has been a large increase of visitors to the British Museum in the day-time during the past year, the number being 517,929, as against 474,765 in 1891. There was also a small increase in the number of evening visitors. The average daily number of visitors in the day-time was 1,660; that of visitors in the evening, 130. The grand total of 558,548 is the highest reached since 1885. The number of visits to the Reading Room was 197,984, as compared with 198,310 in 1891, the daily average being 651. The average numbers in the room counted at certain hours of the afternoon were:—4 p.m., 361; 5 p.m., 272; 6 p.m., 192; 6.30 p.m., 128; 7 p.m., 133; 7.30 p.m., 95. The volumes supplied to readers numbered 1,366,596 (upwards of six daily to each reader), as against 1,269,720 in the previous year. Of the 1,366,596 volumes supplied, 876,776 were returned to the General Library; 16,746 to the Royal Library; 1,469 to the Grenville Library; 2,887 to the Map Room; 465,715 to the presses in which books are kept from day to day for the use of readers; and 3,003 to the Oriental Department. The number of readers in the Newspaper Room was 14,500, and the volumes replaced 46,801, giving a daily average of over three volumes to each reader. To the Map Room 299 visitors were admitted for the purpose of geographical research. The additions to the library were as follows:—(*a.*) 40,903 volumes and pamphlets (including 1,495 books of music and 82 atlases, &c.), of which 12,785 were presented, 12,852 received in pursuance of the laws of English copyright, 663 by international exchange, and 14,603 acquired by purchase; (*b.*) 74,508 parts of volumes (or separate numbers of periodical publications, and of works in progress); and (*c.*) 1,067 maps, in 6,759 sheets; (*d.*) 5,148 pieces of music, each piece complete in itself, acquired by copyright. The number of newspapers published in the United Kingdom, received under the provisions of the Copyright Act during the past year, has been 2,486, comprising 170,618 single numbers; 659 of these newspapers were published in London and its suburbs, 1,400 in other parts of England and Wales, and in the Channel Islands, 232 in Scotland, and 195 in Ireland; 91 volumes, and 234 numbers of old newspapers, belonging to eight different sets, have been purchased; 35 sets, containing 1,267 numbers, of foreign and colonial newspapers have been presented; and 18 volumes and 20,981 numbers of modern foreign and colonial newspapers, belonging to 94 different sets, have been purchased. The number of distinct works comprised in the 40,903 volumes and pamphlets, the 74,508 parts of volumes, the 1,067 maps, and the 5,148 pieces of music already mentioned amounts, as nearly as can be ascertained, to 41,097. The department also received 3,192 articles not included in the foregoing enumeration, comprising broadsides, current Parliamentary papers, and other miscellaneous items. The addition of this number to those already given produces a total of 127,441. The number of manuscripts and documents acquired during the year were:—General collections of MSS., 157: rolls and charters, 808; detached seals and casts, 117; papyri, 13. In the Oriental Department the additions were:—Printed works, 1,167, and MSS., 47. Among the acquisitions was a very handsomely illustrated Burmese MS., containing 39 Jatakas. This MS. includes 81 double folio-sized coloured illustrations, which derive a special interest from the vivid manner in which they depict the dress and manners of the people. It was taken from the library of King Thebaw. Another Burmese MS. consists of the collected writings of Kinwun Mingyi, who was Prime Minister to King Thebaw until the deposition of that sovereign in 1885. Presentations of museum publications, including reproductions of drawings by Old Masters and casts of antique engraved gems, were made to free public libraries, local museums, and art schools throughout the kingdom.

The collections were enriched by the purchase, partly from special Treasury grants and partly from private contributions, of the Royal Gold Cup, a beautiful specimen of mediæval art, which, though French in its origin, formed for nearly 200 years part of the treasure of the Kings of England. The Keeper of British and Mediæval Antiquities, Mr. A. W. Franks, describes this as the most important acquisition of the year, and, indeed, the most important single object acquired by his department since it was established. The cup has had a singular history. "It appears first," Mr. Franks writes, "in an inventory of Charles VI., King of France, so minutely described as to leave no doubt of its identity, with the cup given to that king by his

uncle Jean, Duc de Berry, in 1391. The duke had probably had it made with the intention of giving it to his brother, Charles V., who had a special devotion for St. Agnes, his birthday being on her day; but the death of Charles V. in 1380 may have prevented the gift from being offered. From the inventory, it appears to have had a detached stand with an enamelled medallion of the Virgin, and dragon feet. We next find it, but without the stand, in documents of Henry VI. of England, grandson of Charles VI. How it came to England has not yet been discovered, but it probably was through John, Duke of Bedford, Regent of France, who frequently supplied the necessities of Charles VI., and received from him plate in return. At that time it had an ornamental knot, or 'fruitelet,' of precious stones and pearls, which seems to have been lost or removed by Henry VIII., and replaced by a 'crown imperial,' the newly-invented arched crown of the kings of England, and it is so described in the inventories of Henry VIII. and Queen Elizabeth. In 1610 the Constable of Castile, Don Juan de Velasco, came to England to conclude the peace between the two countries, and James I. was very lavish in his gifts to the envoy, his presents including no less than three gold cups, of which this was one. On his return to Spain, the Constable, who seems to have had a mistaken notion that the cup was a religious vessel, gave it to a convent, and to record his gift, placed a gold band round the stem, enamelled with the following inscription:—"*Gazæ Sacræ ex Anglia reliquias, pacis inter reges factæ monumentum, cratera auro solidum, Joan Velasq. Comestab. inde r[egis] b[ritannici] g[ratia] rediens, Christo pacificatori dd.*' An agent of the abbess of the convent sold it in 1883 to Baron Pichon, of Paris. The history of the cup can, therefore, be traced for 500 years, and it is, as far as is known, the only relic of the domestic plate of the earlier English, or even French, kings. As a specimen of enamelling it is very remarkable, both from the beauty of the design and the extraordinary accuracy of the execution. It is enamelled by the process known as 'translucent on relief,' consisting of variously coloured enamels floated over a very shallow sunk relief, of which the sinkings form the main lines." The other principal donations of the year included a green basalt weight, inscribed with the name of Nebuchadnezzar II., for one *mana*, according to the standard of Dungi, King of Babylonia, about B.C. 2500; marbles and terra-cottas, from excavations at Porta Portese and Civita Lavinia; a very extensive collection of writs of all kinds for various counties of England, *tempp.* Henry IV.—Henry VIII., contributed by the Dean and Chapter of Westminster; a plate of enamelled German ware of great rarity, late 15th century; a collection of Indian coins, and of Burmese coins illustrating the history and development of the coinage of Burma. The sum of £2,000 has been bequeathed by the late Miss Emma T. Turner, to be applied at the discretion of the Trustees of the Museum, for the purpose of excavation, exploration, or survey of sites, in furtherance of the study of the antiquities of Greece, Rome, or Egypt, or of Biblical antiquities.

The number of visitors (including students) to the Natural History Collections was 351,917, as compared with 375,906 in 1891. The Trustees have resolved, with Treasury concurrence, to substitute commissionaires for police constables in warding the exhibition galleries of the Museum, whereby a saving of about £500 annually will be effected, and a step taken in the direction of finding employment for men who have passed through the ranks of the Army and Navy. The recent acquisition of several skeletons of large whales, desiderata to the collection, has caused the Trustees to make a representation to the Treasury as to the extremely inadequate accommodation for the preservation and exhibition of this group of animals, of peculiar interest to a maritime nation like Great Britain. As there seems little prospect at present of the completion of the permanent building by the erection of the wings which form part of the original design, the Trustees, after consultation with the First Commissioner of her Majesty's Works, propose to obtain the sanction of the Lords Commissioners of the Treasury to the erection of a temporary building for the whale skeletons on some of the unoccupied ground at the north-west angle of the Museum, and it is hoped that the work may be commenced and completed during the financial year 1894-95.

General Notes.

PARIS UNIVERSAL EXHIBITION, 1900.—A decree organising the proposed Paris Universal Exhibition of 1900 has been published in the French *Journal Officiel.* Accompanying the decree is a report by the Minister of Commerce, M. Terrier, explaining that the unprecedented scale on which the project is to be carried out, the difficulties which may arise in regard to the retention of some of the buildings on the Champ de Mars, and the means to be adopted for the conveyance of visitors, necessitate this early notification. M. Alfred Picard, who filled the office of *Rapporteur-Général* for the 1889 Exhibition, is appointed Commissary-General. He will be assisted by a Consultative Committee of 100 members, including the Ministers of Commerce, Public Instruction and Fine Arts, and Agriculture, the Under-Secretary of State for the Colonies, eight senators, twelve deputies, the prefects of the Seine and of police, the president and eight members of the Municipal Council, the heads of previous exhibitions, the chairmen of the leading banks, the chiefs of the staff at the Ministries of War and Marine, the managers of the railway, omnibus, and steamboat companies, two representatives of the press, and many minor officials.

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FRIDAY, SEPTEMBER 22, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Chicago Exhibition, 1893.

OFFICIAL CATALOGUE OF THE BRITISH SECTION.

The revised edition of the Official Catalogue of the British Section is now ready, and can be obtained at the offices of the Royal Commission, Society of Arts, John-street, Adelphi, W.C., or from the publishers, Messrs. William Clowes and Sons, Limited, 13, Charing-cross.

Proceedings of the Society.

HOWARD LECTURES.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.

By Prof. W. Cawthorne Unwin, F.R.S.

Lecture III.—Delivered January 27, 1893.

Transmission of Power by Wire-rope Cable.

The origin of the system of telodynamic transmission is interesting. In 1850 there were some large factories at Logelbach, near Colmar in Alsace, which had been standing idle since 1841. It was a question of starting these again as factories for weaving. But there was only one steam-engine, and the buildings were scattered at considerable distances.* It occurred to M. C. F. Hirn to drive one of the factories, at a distance of 80 metres from the steam-engine, by a steel band, used like an ordinary machine belt, on wood pulleys two metres in diameter, and making 120 revolutions per minute. The steel band was about $2\frac{1}{2}$ inches wide and $\frac{1}{24}$th of an inch thick. This band was used for 18 months, transmitting 12 horse-power. Then an English engineer, Mr. Tregoning, suggested the use of a wire-rope cable. A cable of $\frac{1}{4}$ inch in diameter was procured from Messrs. Newall and Company, and replaced the steel band in 1852. The same pulleys were used, with a groove turned in the rim half an inch deep. That cable worked for years, the pulleys, however, being replaced by iron pulleys. A second transmission, to a distance of 240 metres, was soon erected, with pulleys 10 feet in diameter, with a cable half an inch in diameter, running at a speed of about 50 feet per second, and transmitting 40 horse-power. Supporting pulleys were used at the half distance. These transmissions are still working.

M. Hirn has confessed that his chief difficulty at first was the construction of the pulleys. It was not till he adopted a pulley with a dovetailed groove filled with gutta-percha, that he felt the problem of telodynamic transmission to be solved. With these pulleys, neither the pulley nor the cable suffered excessive wear.

The amount of work transmitted by a cable is proportional to the product of the effective tension in the cable and its speed. To transmit power to great distances by manageable cables the strongest material must be used for the cables, and they must be run at the highest practicable speed. The cables were at first of iron, now they are generally of steel. The largest cables which it appears to be practicable to use are about one inch in diameter. In order that the bending stress may not be excessive the pulleys are of large diameter, 12 feet to 15 feet usually. For the throat of the pulley, on which the rope runs, gutta-percha, soft wood, and leather have been used. At present the bottom of the pulley groove is usually formed of strips of waste leather forced into a dovetailed groove. The greatest speed of rope practicable to adopt is that at which the centrifugal tension of the pulley rims becomes dangerous; 100 feet per second has been adopted as the greatest practicable speed. The pulleys are placed at maximum distances of 300 to 500 feet apart. The weight of the rope then ensures sufficient adhesion to prevent slipping, when the ropes are tightened so that the deflection or sag is not inconvenient. With these limitations, a one-inch rope will transmit

* "Notice sur la Transmission Télodynamique," C. F. Hirn, Colmar, 1862. "Note sur la Transmission Télodynamique inventée par M. C. F. Hirn," par M. du Pré, Bruxelles, 1869. "Erfahrungs Resultate über Betrieb und Instandhaltung des Drahtseiltreibs," Ziegler, Winterthur, 1871.

about 330 horse-power. In 1854, M. Henri Schlumberger transmitted the power of a turbine a distance of 80 metres to drive agricultural machinery. In 1862, M. Hirn stated that he knew of more than 400 cases of wire-rope transmission. In ten years, M. Stein, of Mulhouse, is stated to have constructed more than 400 telodynamic transmissions, carrying an aggregate of 4,200 horse-power an aggregate distance of 72,000 metres. It may be mentioned here that the largest telodynamic transmissions have been constructed by Messrs. Rieter Brothers, of Winterthur.

General Description of the System of Transmission by Wire-rope Cable.—The cables used are stranded ropes having six to twelve wires in each strand, and six to ten strands in each rope. (Fig. 13.) The strands are twisted on a hemp core, and usually there is a hemp core to each strand. The hemp makes the ropes flexible. At first, Swedish charcoal iron was used; now, the ropes are more commonly of steel. They are protected from oxidation by a coating of boiled oil. It is necessary to keep a spare rope in reserve, in case of accident.

The ratio of the tensions in the tight and slack sides is about two to one. In passing round the pulleys the rope is bent, and the bending stress is added to the longitudinal stress. In order that the bending stress may not be excessive, large pulleys must be used.

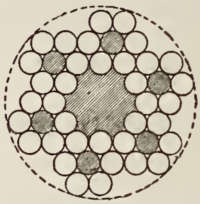

Fig. 13.

Their diameter is so chosen that the bending stress and longitudinal stress are about equal. As the tension in the slack side is less than that in the tight side, supporting pulleys for the slack side may be smaller than the driving pulleys. The following Table gives data of the most extensive cable transmissions:—

Table of Telodynamic Transmissions.

Place.	Total H.P. transmitted.	H.P. on one rope.	Total distance of transmission.	Diameter of pulleys in inches.	Velocity of rope in feet per second.	Diameter of rope in inches.	Diameter of wires in inches.	No. of strands.	No. of wires in each strand.	Total No. of wires.
Oberursel	104	104	3,170	148	73	·63	·07	—	—	48
Schaffhausen ..	560	280	2,700	177	62	1·08	·072	8	10	80
,,	—	150	—	177	—	·88	—	—	—	60
Freiberg	300	300	2,510*	177	62	1·08	·072	10	9	90
,,	—	50	—	108	—	·64	·043	8	9	72
,,	—	120	—	148	—	·72	·060	6	11	66
,,	—	60	—	148	—	·48	·054	6	6	36
,,	—	20	—	84	—	·36	·036	7	6	42
Bellegarde	3,150	300	—	216	65	1·28	·088	8	9	72
Tortona........	8	8	—	78	—	·43	·039	6	8	48
Zurich	250	150	2,500	186 & 127	65	·80	—	—	—	—

* The total distance of transmission at Freiberg is 6,500 feet.

The stretching of the rope when first erected has given rise to some trouble. The hemp cores are compressed, and the rope diminishes in diameter and stretches. Then it requires re-splicing, a troublesome operation. To diminish the difficulty thus caused, Messrs. Rieter Brothers pass the ropes before use between grooved compressing rollers. In ten to fifteen passages of the rope it stretches from 1 to 4 per cent. in length, and its diameter diminishes about 6 per cent.

The piers supporting the pulleys being ex-

pensive, and the pulleys themselves being a cause of waste of power, it is desirable that in a wire-rope transmission the spans should be large. Spans of 300 feet to 500 feet have been commonly adopted. On such spans the deflection of the rope is considerable, and must be provided for by making the pulley piers high enough to keep the cable off the ground. The deflection of the slack side of the rope is greatest, and hence very often the slack side is placed above the tight side.

Arrangement of Spans.—Fig. 14, I. shows

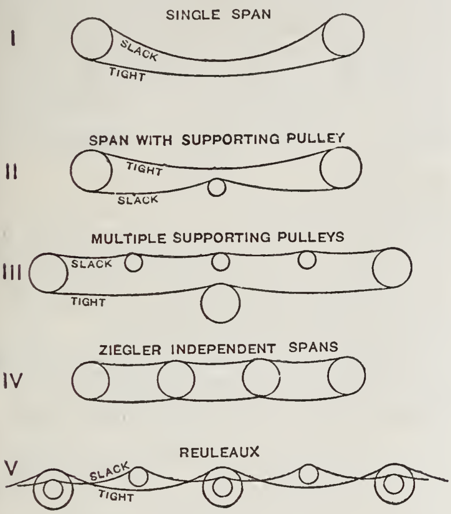

FIG. 14.

an ordinary single span with the deflections of the tight and slack sides of the rope. If the deflection is inconveniently great, it may be diminished by an intermediate supporting pulley. (Fig. 14, II.) When the distance of transmission is too great for one span, a single endless rope may still be used with intermediate supporting pulleys. In some cases it is convenient to have more supporting pulleys for the slack than for the tight side of the rope. At Frankfort, Ziegler constructed the spans with independent ropes. Then the pulleys at intermediate stations must be double grooved. This is the arrangement generally adopted by Messrs. Rieter Brothers, of Winterthur. Prof. Reuleaux has proposed the arrangement, in Fig. 14, V., to reduce the height of the supporting piers. The spans of the slack side of the rope are half those of the tight side, so that the deflections are nearly equal.

In order to give the wire-rope a greater frictional hold on the pulleys, and also to increase its durability, the pulleys have wide **V** grooves, bottomed with some softer substance than iron. (Fig. 15.) At first, Hirn used gutta-percha, pressed into a dovetailed groove; then pinewood strips were used; now, almost universally, strips of leather are pressed into a groove in the pulley edgeways. The pulleys are of cast-iron, or of cast-iron with wrought-iron arms. As the principal part of the waste of work is due to the weight of the pulleys, they should be made as light as possible. The leather packing in the groove requires renewal every three or four months, and involves a not inconsiderable cost of maintenance.

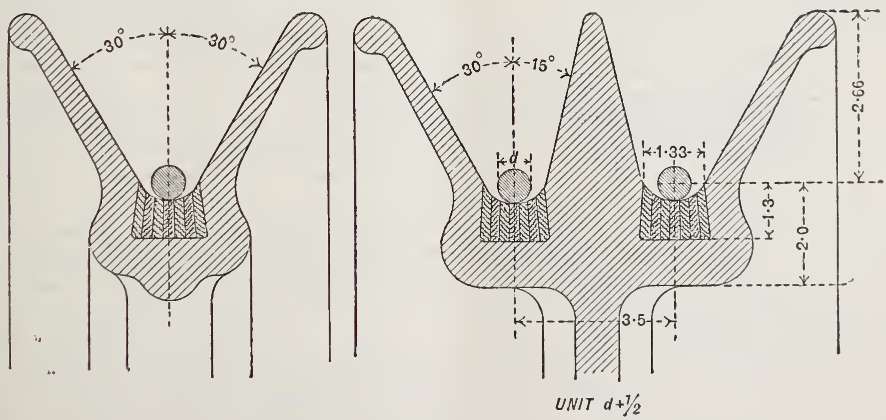

FIG. 15.

The pulley stations are necessarily costly, being lofty, and requiring to be substantially constructed. They are of timber, of iron, or of masonry. Change of direction of the rope has hitherto invariably been effected by bevel-gearing.

Fig. 16. shows one of the masonry piers of the Bellegarde transmission.

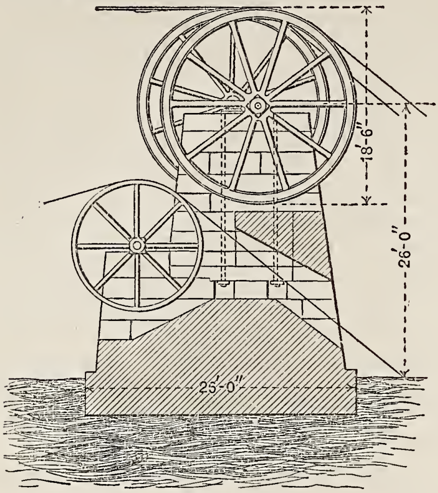

FIG. 16.

Fig. 17 is a change station, where the direction of the ropes is changed.

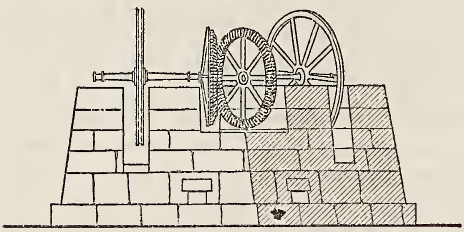

FIG. 17.

Reuleaux has proposed changing the direction by guide pulleys (Fig. 18), which would, doubtless, waste less work.

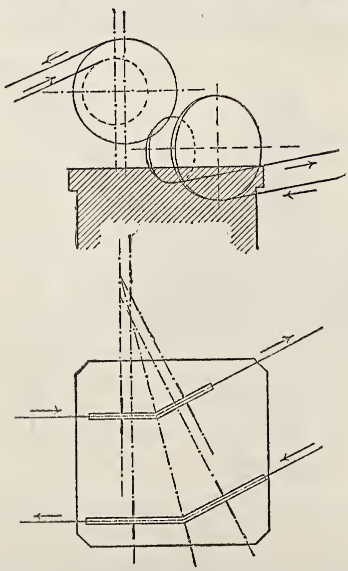

FIG. 18.

Efficiency of Rope Transmission.—The two principal sources of loss of work in telodynamic transmission are the friction of the journals supporting the pulleys and the resistance due to the stiffness of the rope. Ziegler's experiments at Ober Ursel gave for the friction of the journals at one pulley station 1·14 horse-power, and for the work expended in bending the rope 0·625 horse-power, a total of 1·765 horse-power at each pulley station. When transmitting full power, the efficiency of the system is remarkably high. No other mode of transmission to moderate distances involves so little loss of work except electrical transmission. If from Ziegler's experiments the efficiency of each span is taken at 0·962, then for a transmission of m intermediate stations, or $m + 2$ stations altogether, the efficiency is $\eta = 0{\cdot}962^{\frac{m+2}{2}}$

No. of stations ($m + 2$)	2	3	4	5	6	7
Efficiency	0·96	·94	·93	·91	·89	·87

This, however, gives the full load efficiency; with diminished load the loss remains nearly constant, and the efficiency is less.

The Ober-Ursel Transmission.—Not long after the invention of Hirn's system of wire-rope transmission and its application at Logelbach, an opportunity occurred for trying it on a more considerable scale. A cotton mill had been built at Ober Ursel, near Frankfort, to utilise the water-power of the Urselbach. Two tangential wheels were erected on a fall of 165 feet. Their total power varied from 64 to 150 horse-power, according to the condition of the stream. In 1860, more power was required. A fall was found above the mill of 264 feet, but at a distance such that it could not have been made available by ordinary means of transmission. On this fall two tangential wheels were erected, each yielding from 40 to 104 horse-power according to the condition of the stream. The water from the upper turbines afterwards drives the lower turbines. From the upper turbines the power is transmitted by wire-rope cable a distance of 3,160 feet, in seven spans of about 400 feet. The pulleys are $12\frac{1}{2}$ feet in diameter, and the cable $\frac{5}{8}$ inch in diameter. The pulley grooves were lined with leather strips driven edgeways into a groove, a plan now commonly adopted. The pulleys run at $114\frac{1}{2}$ revolutions per minute, and the rope speed is 73 feet per second. The pulleys on the intermediate piers are double grooved, a separate cable being used on each span. Perhaps this was the first completely success-

ful application of telodynamic transmission on a large scale. The work was carried out by Messrs. J. J. Rieter, of Winterthur.

The Ochta Installation.—In 1864, after a serious explosion, the gunpowder factory at Ochta, near St. Petersburg, was reconstructed, and wire-rope transmission was adopted, in order to secure the condition that the dangerous buildings should be at a distance from each other. The motive power of the new factory was supplied by two turbines of 140 horse-power each. A reserve turbine was also erected. The buildings were erected in three lines, one in line with the principal axis of the turbine-house, one parallel to, and 420 feet behind, the former; a third at right angles to the first, in line with the shorter axis of the turbine-house. In each line, the buildings nearest the turbine-house were 330 feet from it. In the first line there were eight buildings requiring 100 horse-power, and the buildings were 164 feet apart, centre to centre. The second line contained twelve buildings placed 230 to 330 feet apart, and requiring 80 horse-power. The third line contained three buildings, requiring 24 horse-power, and placed about 300 feet apart. There were, therefore, 23 buildings, widely scattered, to be supplied with power. The greatest lengths of transmission are 1,300, 2,300, and 2,600 feet. The power was transmitted by wire-rope cables, the work being carried out by M. Stein, of Mulhouse.

The Schaffhausen Transmission.—A still more considerable application of telodynamic transmission, which attracted general attention, was made soon after at Schaffhausen.* After a period of trade depression, there was a revival of industry at Schaffhausen, between 1840 and 1850. In the year 1850, Herr Heinrich Moser, of Charlottenfels, constructed a canal, and erected the first turbine at Schaffhausen. It then occurred to him that it might be possible to render useful the immense volume of water passing down the rapids of the Rhine in front of the town. An extraordinary low condition of the river in the winter 1857-8, favoured an examination of the bed of the river, and a Commission was appointed to mature a project. This Commission suggested the formation of a weir across the river, the construction of a power-house on the right bank, with turbines of 500 horse-power, on a fall of four to six feet; and the transmission of the power across the river to the factories by the then new system of telodynamic transmission. The cost was estimated at £20,000.

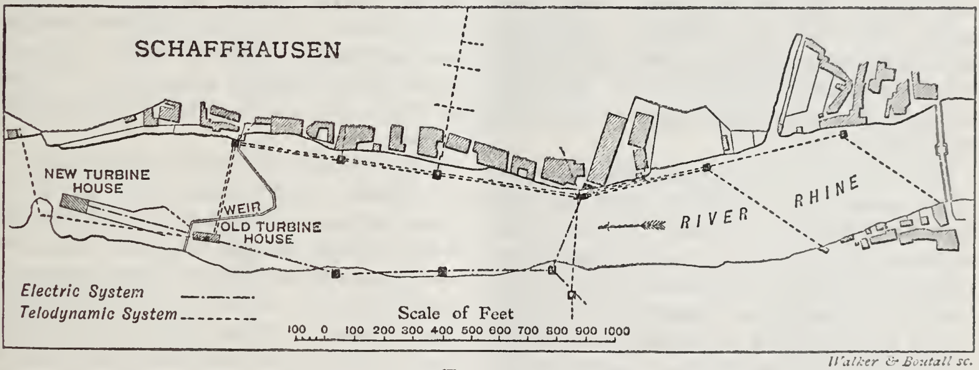

FIG. 19.

Fig. 19 shows the general arrangement of the works at Schaffhausen, with the old turbine-house for the cable transmission, and the new power-house for electric transmission, which will be described later.

A company was formed in 1864 to carry out the works. A weir was constructed during favourable seasons of low water, in 1864-5 and 1865-6, across the river, which is about 500 feet wide. The fall immediately at the weir is not great, but there are rapids below it, and by placing the turbine-house above the weir and constructing a subaqueous tailrace, 620 feet long, a fall was made available, varying from 15·6 feet in low conditions of the river to 13·7 in high conditions. The turbine-house contains three turbines of 200, 260, and 300 horse-power. The turbines are axial flow pressure turbines with vertical shafts, driving a common horizontal shaft by bevil wheels.

* "Turbineanlage und Seil Transmission der Wasserwerkgesellschaft in Schaffhausen," von J. H. Kronauer. Winterthur, 1870. "Die Wasserwerkgesellschaft in Schaffhausen." Schaffhausen, 1889. "Funfundzwanzigster Jahresbericht des Verwaltungsrathes der Wasserwerkgesellschaft in Schaffhausen, 1889." Schaffhausen, 1890.

Two-hundred horse-power is taken directly from one of the turbines and transmitted to a factory on the hill above the turbine-house by a steel shaft 550 feet long. From the same shaft also about 22 horse-power is taken off by a subsidiary wire-rope transmission, which passes down the right bank and then across the river to a pulp factory. There remain about 530 horse-power to be dealt with by the main wire-rope transmission, which passes directly across the river to the left bank, and then along the river bank up the stream on the left shore.

As to the turbines, there is nothing of special interest, except that they are constructed with a partition dividing them into two rings of buckets. During low conditions of the river, when there is a good fall, the outer ring of buckets only is used. When the fall is smaller, both rings are used. This compensates a little for the variation of normal or most economical speed of periphery, with variation of fall. The turbines make 34·28 revolutions per minute. The turbine regulating sluices are under the control of a relay governor. An auxiliary six horse-power turbine works the main sluices of the inlet chamber. There is a friction brake on the main shaft of the turbines, which is thrown into action by the governor, if the speed exceeds a certain limit. Then, if a rope breaks, the friction break comes into action, and stops the turbines. Connected with the brake is an apparatus for determining the power transmitted by the ropes. But the author has not been able to learn whether this is satisfactorily used.

We have now to deal with the principal wire-rope transmission across the river. It has been seen that the turbines drive by bevil wheels a horizontal shaft, each turbine being capable of being disconnected by putting its bevil pinion out of gear. The horizontal shaft makes 80 revolutions per minute, and carries at its driving end two principal rope pulleys of 14·75 feet in diameter. From these pulleys two cables cross the river in a single span of 385 feet to a pulley station in the river at the left bank, where the direction of the transmission is changed by bevil gearing, and thence the transmission passes up the left bank of the river.

The two principal rope-driving pulleys are not keyed on the horizontal driving shaft but run loose on it. Between them is a strong crosshead keyed on the shaft, carrying bevil wheels on studs, which gear into bevil wheels fixed to the driving pulleys. If the tension in the two driving cables are the same, the bevil gearing would have no action. But if there is any difference of tension, the bevil wheels permit one driving pulley to rotate faster than the other so, that equality of tension in the ropes is re-established. This differential gear has not, so far as the author is aware, been elsewhere adopted. Provision is made for keying either driving pulley on the shaft, in the event of one rope breaking, and the power having to be transmitted through the other rope. The differential gear is then out of action.

The gross power in the horizontal driving shaft in the turbine-house is about 530 horse-power, or, allowing for friction, say 500 effective horse-power to be transmitted to the factories, or 250 horse-power for each rope. Either rope is capable of transmitting at any rate a large fraction of the whole power temporarily if the other rope is broken.

This power is delivered by the ropes at the change station on the left bank. At that station about 22 horse-power are taken off by prolonging the second shaft of the bevil-gearing, and a subsidiary rope transmission. The remaining 478 horse-power is transmitted along the left bank to the first intermediate pulley-station, at a distance of 370 feet by a pair of cables. Thence to the second intermediate station, distant 345 feet, by another pair of cables. At 455 feet further is another or second change station, at which the direction is again changed by gearing. Thence the ropes pass to two further intermediate stations.

From the second intermediate station, an underground shaft carries about 27 horse-power to ten small workshops, and from the second change station, and the third and fourth intermediate stations, cables are carried back across the river to factories on the right bank. From the first shaft at the second change station, about 110 horse-power are distributed, partly by a special rope gear, partly by vertical and underground shafting, to four factories, one of which is the large Mosersche Gebaude; and, from the second shaft of this station, a steel shaft transmits 200 horse-power to Scholler's wool factory. Between the turbine-house and the second change station, the cables consist of 80 wires, 0·042″ diam., in 8 strands of 10 wires each, with a hemp core: diameter of rope, 1·08 inch; speed of rope, 62 feet per second. Smaller ropes are used in other parts of the transmission. The distribution has been described rather fully, because it is essential to learn how far wire-

rope transmission can be adapted to complex conditions, where many consumers require power.

It would appear that the rather complex arrangement of differential gear and double cables were intended originally to meet the case of having to drive by a single cable while the other cable was broken or under repair. It appears that, under present conditions, one cable would not be strong enough to transmit the whole power which is utilised; on the other hand, experience has shown that there is no necessity to duplicate the cable to avoid accidental stoppages. The total length of principal transmission is about 2,000 feet.

The Schaffhausen installation has been an entirely successful undertaking, and has very greatly benefited the industries of the town. Some particulars of the extent to which the power has been utilised may be interesting.

Year.	Number of renters of power.	Average total horse-power supplied.	Rent from power.
			£
1867	13	121	345
1868	13	150	585
1869	14	180	730
1870	15	254	830
1871	16	293	1,215
1872	17	337	1,510
1873	17	350	1,650
1874	19	483	2,300
1875	21	527	2,520
1876	23	595	2,800
1877	23	597	3,000
1878	23	610	3,060
1879	23	610	3,040
1880	24	623	3,120
1881	23	634	3,100
1882	23	641	3,200
1883	23	639	3,240
1884	22	641	3,080
1885	23	632	2,880
1886	23	639	3,080
1887	23	641	3,300

The charge for power in 1887 varied from £4 16s. to £6 per horse-power per annum.

The total cost of the works appears to have been reckoned at £29,360 originally, and this, by writing off, stood at £24,664 in 1887.

As to the working of the system it appears that experience has proved that there is a greater loss of power in transmission in wet and frosty weather than was originally expected. When the maximum power is being used, there are oscillations of the ropes which drive the machines at irregular speed. The spinning factory suffered most from this and ceased to take power. This has led to the construction of a new power-station and the adoption in the new works of electrical instead of wire-rope transmission.

In some excellent lectures which were delivered before this Society in 1891 by Mr. Gisbert Kapp, the method of transmission by wire-rope is compared with the method of transmission electrically very much to the disadvantage of the former. "Till recently," said Mr. Kapp, "rope transmission held the field absolutely, not because it was perfect but because there was nothing better. Now, however, we have something better in electrical distribution, and the flying ropes are being steadily replaced by the electric conductors." The use of the word replaced conveys a wrong impression. The wire ropes have not been replaced at Schaffhausen by electric cables, but an additional power-station has been erected and an electric transmission has been placed beside the rope transmission. It happened accidentally that at a visit of the author to Schaffhausen, about a year and a half since, the rope transmission was working while the electric transmission was stopped, having been temporarily disabled by a lightning accident. It seemed desirable to ascertain from Messrs. Rieter what view they took of the prospects of wire-rope transmission, looking to the fact that they had the opportunity of knowing the results of the working of rope and electric transmission side by side. They were good enough to send answers to some inquiries. They say that, at Schaffhausen, the rope plant is expected to do more work than was originally provided for or intended; also, it was the first large installation of the kind, and had some defects, which experience has shown can be remedied. Electric transmission, they say, has also been found to have some inconveniences. They, however, do not think that electric transmission will compete seriously with rope transmission for short distances, such as that at Schaffhausen, as I understand them; on

the other hand, for long distances, they admit that electric transmission has the advantage.

Transmission at Tortona in Italy.—As early as 1876, and apparently independently of Hirn, an Italian engineer* erected a small small cable transmission, worked from a water wheel, at Tortona. There is a single span of 400 feet. The water-wheel drives the first rope pulley by gearing, with a ratio of 19 to 1. The rope speed is 50 feet per second. The most interesting points about the transmission are—(1) That, in spite of the disadvantages of gearing, and the smallness of the power transmitted (seven or eight horse-power), the loss in normal conditions of working appeared to be only six per cent.; and (2) that the substitution of water-power and rope transmission for steam, effected an economy of 60 per cent.

The Installation at Fribourg, Switzerland.—A company was formed in 1870, partly to acquire and work the forests owned by the town of Fribourg, partly to utilise and sell water-power, and partly to carry out a scheme of water supply. This was, to some extent, a scheme in advance of any previous one, because the company acquired land which they proposed to lease to industrial undertakings, including in the lease a right to a supply of power from the plant of the company.

A dam, 40 feet high, was built across the River Sarine, near the town, in a ravine where it was not possible to construct factories. The company, therefore, acquired some level land about 300 feet above the river, adjoining a railway and otherwise well adapted for factories. The factories were to be worked by power transmitted by wire ropes from the power-station at the river.

With the minimum flow of the Sarine and an effective fall of 35 feet, 1,700 horse-power could be obtained. Provision was made for two turbine-houses containing eight turbines of 300 horse-power each. Only two turbines have actually been constructed, one driving pumping machinery for water supply, the other driving a rope transmission. The turbines are Girard turbines, running at 74½ revolutions per minute. The turbine for transmission drives a horizontal shaft at 81 revolutions per minute by bevil wheels. This carries a 15 feet pulley with single groove driving the cable, by which power is transmitted to the plain of Perolles. The principal rope transmission consists of five equal spans of 500 feet each. The total distance to the saw-mill, at which power is first taken is 2,500 feet, and the difference of elevation is 268 feet. The rope pulleys are all 15 feet in diameter, and the rope is 1·08 in diameter. The rope consists of 90 wires ·072″ diameter in ten strands of nine wires with hemp cores. The speed of the rope is 62 feet per second. At the sawmill a subsidiary transmission works a railway for carrying timber and using 50 horse-power. This has a rope 5-8ths of an inch in diameter. From the shafting of the saw-mill another subsidiary rope transmission takes 120 horse-power to railway carriage works, at a distance of 930 feet. From the carriage works there is a further transmission of 60 horse-power by a ½-inch rope a distance of 1,600 feet, and thence by ropes, 3-8ths inch in diameter, to a foundry and chemical factory. The power is sold at the rate of 200 frs., or £8 per horse-power per annum.

It was at Fribourg that Messrs. Rieter introduced the plan of employing ropes, previously stretched, so that they should not require to be shortened after being some time in use. The ropes are stretched 0·71 to 2·6 per cent. of their length by a machine, which compresses them radially, while a longitudinal tension is also applied.

The Installation at Bellegarde.—In 1872, a company was formed to utilise the water-power of the Rhone, at Bellegarde, not very far from Geneva. The total power of the river which is available is estimated at 12,000 horse-power; but the original project, which was on a very large scale, has been only partially carried out, and the works have not been financially successful.

The water is led from a point above the Perte du Rhone, through a tunnel 1,800 feet in length, to the Valserine, near its junction with the Rhone. A turbine-house has been erected, with five Jonval turbines, on a fall of 36 feet, developing 630 horse-power each. The power is sold at 200 frs. to 300 frs., or at £8 to £12 per horse-power per annum. Quarries of deposits of phosphate of lime, a wood pulp factory and paper-mill, a copper refinery, and other works, are driven by the turbines.

The turbines are in a gorge. The wire ropes are led from pulleys on the turbine shafts to a pulley station, distant 120 feet vertically above the turbines, and 200 feet horizontally. The total distance to the phosphate factory is 3,000 feet.

The horizontal shafts driven by the turbines carry each two pulleys, 18 feet diameter, with

* N. Ruggeri, "Proc. Inst. Civil Engineers," vol. l. p. 192.

ropes 1·28 inches in diameter, consisting of 72 wires, ·081 inch in diameter, with a hemp core. The rope speed is 66 feet per second. The greatest span at Bellegarde is 630 feet.

The Installation at Gokak, in India.—The most recent and one of the largest telodynamic transmissions has been erected at Gokak in the southern Mahratta country in India. This installation has been carried out by Messrs. Escher Wyss, of Zurich.*

The river falling over a high cliff has motive-power enough for many industries. At present three turbines of 250 horse-power each (750 horse-power altogether) have been erected to drive a cotton-mill of 20,000 spindles. The water taken at 2,300 feet above the fall is led by a channel to the edge of the cliff, and thence in a 32-inch wrought-iron pipe. The pipe descends about 110 feet vertically on the face of the cliff and then is inclined at about 30° to the horizontal. In the turbine-house the three turbines are supplied by three 24″ branch pipes. The total fall acting at the turbines is 180⅓ feet. The turbine wheels are 67 inches in diameter, and they run at 155 revolutions per minute.

The turbines are action or impulse turbines with partial admission; and they have horizontal axes, each turbine axis carrying a wire-rope driving pulley. There is a sluice valve, worked by hand, and a throttle, or disc valve, controlled by a governor, to each turbine. The governor is a relay governor, in which a belt on speed cones drives differential gearing connected with the throttle valve. If the governor moves the belt to either side of its central position, the differential gear comes into operation, and opens or closes the throttle valve.

The shafts of the turbines carry wire-rope pulleys 11½ feet in diameter. The rope speed is 93 feet per second; the ropes are 1 inch diameter. At the top of the cliff is a rope station, with carrier pulleys 198 and 220 feet above the turbine shafts. The pulley for the tight side of belt is 11½ feet diameter; that for the slack side is 8 feet in diameter. The distance from this station to the mill is 432 feet, and there is an intermediate carrier station for the slack side of the belt, which would otherwise foul the ground. There are, of course, three ropes, one to each turbine. The installation was set to work in October, 1887.

Advantages and Disadvantages of the Telodynamic System.—The telodynamic system is adapted for transmitting and distributing power to distances of a mile or more, which are large compared with the distances to which power is ordinarily transmitted by shafting and similar means. On the other hand, it cannot seriously compete with electrical transmission in cases where the distance to be covered is reckoned by many miles. With this limitation it may be noted that—

(1.) It has the peculiar advantage that it transmits the mechanical energy developed by the prime mover directly without any intermediate transformation. In electrical distribution, a double transformation is necessary—a transformation into electrical energy by a dynamo, and re-transformation back into mechanical energy by an electric motor. This double transformation involves waste of power, and increase of capital expended.

(2.) The efficiency of transmission to such distances as those at Schaffhausen is undoubtedly very great; it is uncertain whether a similar amount of power could be distributed to an equal number of consumers electrically with as little waste of energy in the process.

(3.) The telodynamic transmissions which have been at work, some of them since 1864, have actually worked continuously, without serious stoppage, and have only failed to return an adequate profit where they were undertaken on a scale too large for the amount of industry requiring to be supplied with power in the locality.

(4.) Where, as at Bellegarde and Fribourg, the power-station is 150 or more feet below the factories driven, the telodynamic system has an advantage over some systems, such as the hydraulic system, that there is no loss of efficiency due to difference of level.

On the other hand, it may be admitted that telodynamic transmissions, simple as they are mechanically, involve considerable cost. The pulley piers require to be lofty, and strongly built. The maximum length of span hitherto accomplished is 630 feet at Bellegarde. Experience has also shown that the cost of maintenance is considerable. The cables must be replaced annually, and experienced workmen are necessary to make the long splices in the ropes.

One distinct disadvantage of the telodynamic system is, that no means has been found of directly measuring, by numerous or continuous observations, the amount of power delivered to each consumer. So long as the power is distributed to very few consumers, it is possible to assess, with practical fairness, the charge

* *Engineering*, June 8, 1888.

to each, without such measurements of the power. But, in proportion as the consumers are more numerous, the defect of the system in this respect becomes more serious. A recording transmission dynamometer would, of course, obviate the difficulty, but the cost of such an appliance is considerable.

It is, in some cases at any rate, a defect of the cable system that the amount of power which it is practically possible to transmit by a single cable is limited. It is not possible by increasing the size of the cable to transmit an indefinitely large amount of power. The cables became too heavy to be manageable, and the pulleys too large in diameter. In the report of the experts advising the town of Geneva, in 1889, the limit for one cable was placed at 100 horse-power; Messrs. Rieter Brothers place it at 300 horse-power, and that amount has, in fact, been transmitted; no doubt the proper limit varies in different cases.

It is also an inherent characteristic of the cable system that the efficiency decreases rapidly when the distance increases beyond certain moderate limits. On the most favourable interpretation of the experiments the efficiency may be ·96 for 100 yards or ·93 for 500 yards, efficiencies remarkably high. But the efficiency falls to 0·60 for 5,000 yards, an efficiency by no means remarkably good.

Miscellaneous.

*LACE MACHINERY.**

By E. Doughty.

The commencement of the machine for making lace may be dated about 1764, when the old-fashioned stocking machine had been in existence about 200 years, about which time certain discoveries and improvements were made which enabled it to produce a net, at that time considered to be a great achievement, thus making the stocking machine virtually the first lace machine. In the course of the next few years various other improvements by skilful mechanics were made, which ultimately ended in producing a very useful net for embroidering purposes, finding employment for a large number of machines, as well as women and girls.

Very slow progress was made in the development of invention; but this is, perhaps, not much to be surprised at, considering that the ordinary mechanical tools in use were of the simplest description: there were no labour-saving self-acting tools with a steam-engine for motive power to be found in any workshop then, and every tool, except files, had to be made by the workman himself, who also had to make every screw, bolt, and nut that he required.

* Paper read at Nottingham before Section G of the British Association, September, 1893.

The absolute necessity to supply himself with nearly every one of his requirements made the mechanic of that time a man of great resources, and contributed very much to his inventive faculties. At that time nearly every part of the machine was constructed of wrought iron, except the large framework, which was made of wood, cast-iron being almost unknown then in machine-making.

Further developments of the stocking machine led to the making of the warp machine, which had many details in common with its original, though very different in some respects. At one time great numbers of warp machines were employed in making a very useful cloth with which our sailors were clothed for years. Similar cloth has come into use again the last ten years, under the name of stockinette, being very elastic.

But a net was wanted, like that made by hand on the Continent, called Brussels net. After many trials by inventors, Heathcote succeeded in making the exact net itself, and resulted in making his fortune, though it ruined hundreds of machine-owners who made net that had previously been used for the same purpose. Heathcote's machine was protected by patents, which many tried to evade by making the net on other machines. One man, named Leavers, originated a different machine which, after many alterations, has come down to our time as the most useful lace machine we have.

Another machine was developed out of the plain net machine for making lace curtains.

*KNITTING MACHINERY.**

By Chas. R. Woodward.

The paper opens with historical references to the early forms of machinery for knitting, and shows what enormous strides have been made in improving their mechanical design and construction, what great progress in loop-forming capacity—advancing from 500 to 500,000 loops per minute—and how large and varied is the present scope of the trade, embracing, as it does, not only all forms of knitted underwear, but also stockinette cloth, astrachans, Cardigan jackets, Tam-o'-Shanter caps, down to bags in which to import foreign mutton. The new era in the making of stockings is next specially dwelt on and the main reasons given for the return to domestic machinery, among which are its cheapness, the low rate of wages for which country people will work, the fact that the goods require so little finishing, that manufacturers

* Paper read at Nottingham before Section G of the British Association, September, 1893.

have no factory expenses, and that much more comfortable socks and stockings are produced on these machines than on earlier types. The attempts recently made to successfully compete with the domestic machinery are next mentioned, the cosmopolitan spirit of Nottingham machinists shown in their introducing American machines into England, chief among which machines are the "Shaw," "Scott and Williams," and "Aiken" machines, on which one girl will knit from fifty to eighty dozen pairs of half-hose per week, but which, unlike their rivals, are confined to the making of plain, *i.e.*, not ribbed fabrics. The probable lines of future development, though somewhat difficult to forecast, are indicated, and may be summarised thus:—Machinery which will work either by foot-pedals or steam-power, and in which the narrowing, widening, changing of ribs, and forming of heels, toes, &c., will be manipulated by hand in a similar manner to that in which a typewriter is worked.

*ON ANTHROPOMETRIC WORK IN LARGE SCHOOLS.**

By Bertram C. A. Windle, D.Sc , M.D., M.A.

This paper gives the results obtained in answer to a circular sent to the head masters of one hundred of the largest schools in England, Scotland, and Ireland, inquiring whether any, and if so what, anthropometric investigations were carried on in their institutions, and the methods adopted in taking the various measurements. The replies show that some form of measurement is, or has been, carried on in twenty-five schools, details of which will be found in the Table below (No. 1). They also show that the methods adopted differ considerably (Table No. 2), a fact which somewhat detracts from the value of the observations for comparative purposes.

The advantages of systematic measurements of boys from the scholastic and the scientific points of view are alluded to, and it is suggested that an endeavour should be made to encourage and systematise such work in large schools.

Table 1.—Measurements Taken.

(*Number of Schools*, 25.)

Height	25	Length of forearm	3
Weight	21	Girth ,,	10
Chest girth	23	Sight	5
Size of head	0	Colour blindness	1
Length of arm	3	Hearing	1
Girth ,,	10	Lift, or Archer's pull	2

Table 2.—Methods of Taking Measurements.

Height.

In boots	1	In bare feet	1
In gymnastic shoes	3	Not mentioned	5
In socks	15		

Weight.

In ordinary clothes	2	Naked	0
In gymnastic	15	Not mentioned	4

Chest Girth.

In ordinary clothes	0	Naked	12
In gymnastic	7	Not mentioned	4

* Paper read at Nottingham before Section H of the British Association, September, 1893.

VITICULTURE IN CRETE.

The *Journal de la Chambre de Commerce de Constantinople* says that about fifteen years ago viticulture in Crete attained such a pitch of development that the population neglected every other description of culture and devoted themselves entirely to the industry of wine - growing. At this period the phylloxera was devastating the French vineyards, and in order to make up for the deficiency of her own harvests, France was obliged to have recourse to foreign importations of wine, and considerable quantities were drawn from the island of Crete. Prices at present are so little remunerative that, not only is there less attention paid to viticulture in the island, but the vineyards in many cases are being abandoned. This condition of affairs is not entirely caused by the absence of outlets for Cretan wines; it may, in part, be accounted for by the defective methods of making the wine, and, in part, by the system of plastering. As a means of encouraging the industry, the Administrative Council of the Vilayet of Crete lately decided that it would be of advantage to establish, in a convenient position, a model wine factory, and to appoint a French specialist to instruct the growers in the best systems of wine-making. It was hoped that, by the establishment of this factory, it would be possible to obtain samples of the best qualities of Cretan wine, derived from each description of grape cultivated in the island, and, by means of these samples, develop the trade on foreign markets. Cretan wines are of considerable alcoholic strength, and are therefore well adapted for blending with French wines of an inferior quality. Many descriptions of grapes are cultivated in Crete. In the districts situated in the north of the island a white grape, known as *courou-tahta*, is largely grown, and these are employed as well for drying as for wine-making. This grape holds the first place, and after it comes the black grape, known as the *liatiko*, which is almost exclusively employed in wine-making. Then follows the description called *razaki*, which is much appreciated by consumers of fresh grapes, and enjoys a high reputation in Crete. This grape can be harvested until the end of November. This fruit also, when dried, is in great request. The following descriptions are also cultivated, although on a somewhat smaller scale—the *mandilari*, *kotchifali*, *komiano* and *romeïko*, the latter being more particularly grown in districts situated in the west of the island and used only for wine-making. The wines made from the above descriptions of grapes are very strong

and of good quality. The *courou-tahta, razaki,* and *kotchifali* grapes thrive best in calcareous soil, while the *liatiko* and the *komiano* flourish best in sandy soil. Vineyard proprietors in the towns sell their grapes to the wine makers who are established in their districts, while as regards the rural population they themselves engage in wine-making, the transport of the wine being less costly than that of the grapes —and moreover the grape cake can be utilised in the manufacture of brandy or for manuring the fields. Among the wine-producing districts, that of Canea takes the first rank for the quality of its products, and the vineyards of this sandjak are the best looked after of any in the island. The grapes that are grown there being of a very superior quality, a large trade in the export of raisins is also carried on. These are chiefly consigned to Trieste.

General Notes.

Japan Society.—The first meeting of the third Session of the Japan Society will be held on Wednesday evening, 27th inst., at 20, Hanover-square, when Prof. John Milne, F.R.S., will read "A Short Account of Volcanic and Earthquake Phenomena of Japan."

Photographic Society.—The Twenty-eighth Annual Exhibition will be opened on Monday, 25th inst.; and on Tuesday, 26th, a Technical Meeting will be held at the Gallery, 5A, Pall-mall East, when an explanation of the apparatus in the Exhibition will be given by the exhibitors.

Royal Geographical Society.—A course of twelve Educational Lectures on the "Principles of Commercial Geography as applied to the British Empire," by Hugh Robert Mill, D.Sc., has been arranged by the Royal Geographical Society to be held at the London Institution, Finsbury-circus, on Tuesday evenings, at 6 p.m. The course to commence on October 3rd.

Swiney Lectures on Geology.—Under the direction of the Trustees of the British Museum, Professor H. Alleyne Nicholson, M.D., D.Sc., F.G.S., will deliver a course of twelve lectures on "The Bearings of Geology on the Distribution of Animals and Plants," at the South Kensington Museum, on Mondays, Wednesdays, and Fridays, at 3 p.m., beginning Monday, October 2, and ending Friday, October 27. Admission to the course is free.

Vienna International Art Exhibition, 1894.—The programme of this Exhibition, to be held from March 1 to May 31, 1894, has been received from the Science and Art Department. The aim of the organisers, the "Association des Artistes de Vienne," is to present as complete a picture as possible of contemporary art, and separate space will be provided for each competing country. The invitation to foreign nations to participate has been issued in the name of the Austrian Government, who offer a number of gold medals. Special prizes are also to be given, among the donors being the Emperor and the Archduke Charles Louis. It is further announced that steps have been taken to arrange for "acquisitions importantes" by his Majesty as well as by the State and the city of Vienna. A lottery to be held in connection with the Exhibition will contribute to the sale of works exhibited, while the Artists' Association and the Sculptors' Club propose to make some purchases. Architecture, sculpture, painting, and engraving will be all represented. Applications for space must be made by January 15 at the latest, and exhibits delivered by February 1. All communications should be addressed to the "Commission den III. internationalen Kunstansstellung, 1894, in Wien, Künstlerhaus, I. Lothringerstrasse 9."

Smokeless Combustion.—Some trials at Berlin for securing complete combuston with the absence of smoke have, it is stated, induced the North German Lloyd and the Hamburg American Packet Company to adopt the system, which is thus described: — Coal, reduced to powder — not necessarily very fine, however—in centrifugal disintegrators, is introduced into a pear-shaped combustion-chamber lined with firebrick, and fitted with an induction-apparatus like those used in petroleum-fired furnaces, the coal-dust being drawn along by a jet of steam or compressed air. The combustion-chamber, which takes the place of a furnace, is provided with two apertures, one in the centre line of the boiler — in case of such an application, for instance—occupying the position of the usual fire-hole door, while the other, on the opposite side of the combustion-chamber, serves for introducing the coal-dust through a pipe, so placed that the dust is evenly dispersed over the whole extent of the chamber. After the first ignition of the dust, which may be affected by any source of heat, the combustion is said to continue very intensely and regularly under the action of the air-current, which is regulated in accordance with the quantity of dust necessary to produce the degree of heat for the required amount of steam. The air or steam and coal-dust are intimately mingled in the zone of combustion, while the speed of the current, which has served as a vehicle for the dust, is very much reduced. Each particle of fuel held in suspension is, by this method, brought into such intimate contact with the oxygen necessary for its combustion, that this combustion is so complete as to allow scarcely any smoke to be perceptible. The air introduced into the combustion-chamber may also be previously heated by the waste gases, so as to constitute a regenerative system capable of affording an intense heat for metallurgical purposes.

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Proceedings of the Society.

HOWARD LECTURES.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.

By Prof. W. Cawthorne Unwin, F.R.S.

Lecture IV.—Delivered February 3, 1893.

Hydraulic Transmission.

The practical application of a system of distribution of pressure-water for motive power purposes is due to Lord Armstrong. From the first, Lord Armstrong contemplated a distribution of pressure-water in town areas for the supply of motive power to many consumers. For that purpose the supply of water for motive power purposes may be conjoined with the supply of water for other purposes, the motors being driven by water from the ordinary town mains. In that case no special system of mains for power-water is required; but, on the other hand, the pressure is limited to that suitable for ordinary water supply. Or a special system of distribution of power-water may be adopted, and in that case it generally proves to be convenient and economical to use a much higher pressure than would be suitable for ordinary water supply. For a long time the installations carried out for the hydraulic distribution of power were of a local and restricted character, and were special systems of the latter kind. Only in a few towns pressure-water for a small number of motors was obtained from the ordinary mains, the price charged for the water being so great that it was preferable, in most cases, to use steam or gas-engines. The advantages of hydraulic transmission for actuating machines, which work intermittently, such as cranes, lifts, capstans, and dock gates, were soon obvious. For this particular purpose, it is convenient to use exceptionally high pressure with small mains and comparatively small motor cylinders. Such high-pressure hydraulic transmissions were first erected in connection with docks and arsenals. It was only after many years that similar systems came to be applied for power supply over extensive town districts. The conditions under which high pressure systems first achieved success gave them a special character, which imposes definite limitations on their application. The high-pressure system is almost exclusively an English system, and almost exclusively suitable for working intermittent machines. For ordinary power purposes it is less well adapted. Comparatively recently systems of hydraulic transmission at more moderate pressure have been carried out, which are better suited to distribute power for ordinary industrial purposes.

In driving cranes and other intermittently working machines the fluctuation in the demand on the mains for pressure-water is very great. Hence in developing his system Lord Armstrong was led very soon to consider the question of the storage of energy. Reservoir storage for systems in which the pressure is very great is not generally possible, because no site sufficiently elevated can be found for the reservoir. Air vessels were considered, but the amount of energy which can be stored in that way is not very great and there are practical difficulties. The pressure in the air vessel varies with the quantity of water in store, and an air pump must be used to replace the air absorbed and to maintain the air cushion. The invention of the accumulator met the difficulty. The accumulator perfectly answers the purpose of storing such a supply of water under pressure as is required to meet the momentary fluctuations of demand in a system driving intermittent machines.

In an article in the *Mechanics' Magazine*, in 1840,* very interesting now, if its date is considered, Lord Armstrong pointed out that when water is lifted by a pumping-engine, it becomes the recipient of the energy expended in raising it. If the same water is used to actuate motors, it renders back the power conferred on it in its descent to its original level, and thus becomes a medium through which the power of the pumping-engine may be transmitted to a distance and distributed in large or small quantities as required. Lord Armstrong showed that a continuously working steam-pumping engine, of comparatively small size, was capable of doing a large

* See the "Proc. Inst. of Civil Engineers," vol. l., p. 66.

amount of distributed intermittent work, and he argued that this would be more economical than the employment of a number of steam motors to drive each separate machine.

Soon after this, Lord Armstrong invented an hydraulic crane of a type used ever since. The pressure-water acts on a piston, the motion of which is multiplied by reduplicating a chain over pulleys. In 1845, a crane, worked by pressure water from the town mains, was erected in Newcastle; and, in 1848, similar cranes were used by the North-Eastern Railway, at their goods station in Newcastle. In 1851, hydraulic transmission was adopted for driving cranes and working dock gates at Great Grimsby, at New Holland, on the Humber, and by Brunel on the Great Western Railway.

High and Low-pressure Systems.—Systems of hydraulic transmission are of two distinct types:—First, there are systems which, for convenience, may be termed low-pressure systems, with reservoir storage. In these the working pressure is fixed by local conditions, especially by conditions determining the site for the reservoir. Generally, the pressure is not more than 400 to 600 feet. It is the reservoir storage in these systems which, more than anything else, makes them suitable for the supply of power for all ordinary industrial purposes, for driving factories or electric light stations, for instance, involving a large continuous demand for power extending over considerable periods of time. Secondly, there are systems which, for convenience, may be termed high-pressure systems, with accumulator storage. The pressure in these systems is usually 700 to 800 lbs. per square inch, or 1,600 to 1,800 feet of head. These systems, in which the reverse of energy is limited in amount, are most suitable for working cranes and lifts, hydraulic presses, and similar intermittently-working machines.

Amount of Energy Transmitted in Pipes by Pressure-water.—The velocity of water in pipes cannot be made very great without excessive frictional loss, or without incurring danger from hydraulic shock. A velocity of three feet per second is very commonly permitted, and, perhaps, this might be doubled without excessive loss or risk.

Let d be the internal diameter of the pipe in inches; p the working pressure in lbs. per square inch; H the head due to the pressure, so that $p = 0{\cdot}433$ H; v the velocity in feet per second. Then the gross work transmitted is—

$$\text{U.} = \frac{\pi}{4} d^2 p v \quad \text{ft. lbs. per sec.}$$
$$= 0{\cdot}34\, d^2 \text{H} v \quad ,, \quad ,,$$

or in horse-power—

$$\text{H.P.} = {\cdot}001428\ d^2\ p\ v$$
$$= {\cdot}000618\ d^2\ \text{H}\ v$$

GROSS HORSE-POWER TRANSMITTED BY DIFFERENT MAINS.

Low-pressure System.

Head, 500 feet.

Diameter of Main in inches.	Gross H.P. Transmitted.
9	75
12	133
18	300
24	533

High-pressure System.

Pressure, 750 lbs. per square inch.

Diameter of Main in inches.	Gross H.P. Transmitted.
3	29
6	116
9	260
12	463

At 3 feet per second, and with a pressure of 500 feet, as at Zurich, a 12-inch main would transmit 133 horse-power, and a 24-inch main 533 horse-power. Mains of this size can be used with such a pressure. With the high-pressure of 750 lbs. per square inch, and at the same velocity, as in the case of the London Hydraulic Power system, a 6-inch main transmits 116 horse-power, and a 12-inch main, if it could be safely used, would transmit 463 horse-power. The horse-power is gross horse-power, without allowing for loss in the motors.

In neither the high-pressure nor the low-pressure system, is the amount of power which can be transmitted by a single main very great. This involves a definite limitation of hydraulic systems. They are best adapted for driving machines working only a fraction of the 24 hours, or for motors for small industries not requiring a great amount of power.

Loss of Pressure due to Friction in the Mains.—At a velocity of 3 feet per second the loss of pressure per mile of main, due to fric-

tion, is about 18 lbs. per square inch in a 6-inch main; about 9 lbs. per square inch in a 12-inch main, and about $4\frac{1}{2}$ lbs. per square inch in a 24-inch main. These losses are insignificant on a high-pressure system, and not very important on a low-pressure system, with distances of transmission such as are practically attempted. The losses of energy due to distribution in an hydraulic system, apart from those due to the pumping or motor machines, are so small in most cases, that they may be dismissed from consideration without any very serious error.

The following Table gives the loss due to friction at a velocity of 3 feet per second per mile of main :—

Diameter of main in inches.	Loss due to friction per mile.			
	In feet of head.		In lbs. per sq. in.	
	Clean.	Incrusted.	Clean.	Incrusted.
6	35·5	70·9	15·37	30·70
12	16·3	32·5	7·06	14·07
24	7·4	14·8	3·20	6·41

For rough calculations, the loss of pressure per mile may be taken at 107/d lbs. per square inch. The per-centage loss per mile, reckoned on the working pressure, is as follows :—

NEW AND CLEAN PIPES.

Diameter in inches.	For Pressure in feet of				
	100	250	500	1,000	1,600
6	35·5	14·2	7·1	3·5	2·2
12	16·3	6·6	3·3	1·6	1·0
24	7·4	2·8	1·4	0·7	0·5

With incrusted pipes the per-centage loss is double as great. The loss in any case is not very important for working pressures of more than 500 feet of head and distances of transmission likely to be attempted. For small working pressures, or greater velocity in the main, the frictional losses become much more important. That is one reason why high working pressures are advantageous in hydraulic systems.

Considerations arising out of the Strength of the Pipes.—In all hydraulic systems at high pressure in this country cast-iron pipes have been used, with a peculiar flanged joint having two bolts. Mr. Ellington's experience in London shows that a main of this kind can be made absolutely tight and free from leakage. The largest mains used are $7\frac{1}{2}$ inches in diameter. The working stress in the metal, due to the water pressure, is 2,800 lbs. per square inch. The mains are usually tested to a water pressure of 2,500 lbs. per square inch before laying, and to a pressure of 800 to 1,600 lbs. per square inch after laying.

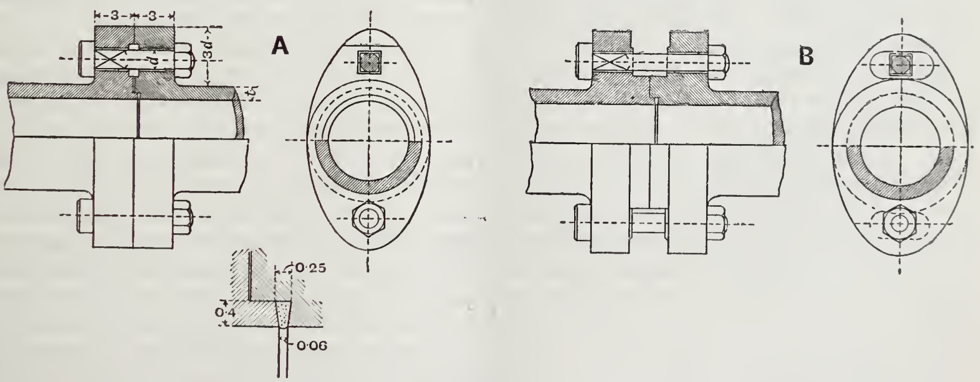


FIG. 20.

Fig. 20 shows at A the form of joint used by Lord Armstrong, and at B a modification introduced by Mr. Ellington. The joint is made tight by a guttapercha ring. The flanges are placed in a horizontal position in laying. Mr. Ellington found that fractures in the pipes occurred by the breaking off of one of the lugs for the bolts. By placing the lugs a little further back on the pipe the strength was found to be greater. Probably the slight flexibility of the pipe line that this form of joint allows is an important element in its success.

Probably, solid drawn steel pipes would now be used, if a suitable joint for them could be devised. Such pipes were proposed to be used in a project submitted to the Niagara Commission by MM. Vigreux and Feray. For steel pipes, a stress of 15,000 lbs. per square in. might be allowed; and the use of such pipes would much extend the capabilities of the high-pressure hydraulic system. On low-pressure hydraulic systems, ordinary socket pipes can be used.

Considerations arising out of the Weight and Cost of the Distributing Mains.—For pipes of equal strength, and at a given limiting velocity of flow, the weight of mains is simply proportional to the horse-power transmitted. Hence, so far as cost of mains is concerned, the low-pressure system is as economical as the high-pressure system. No doubt, however, if all practical exigencies are taken into account, the cost of mains is somewhat greater for low-pressure than for high-pressure systems.

Considerations arising out of the Type of Motors Driven by the Pressure-water.—On high-pressure systems the motors used are almost exclusively pressure engines, that is, motors with reciprocating plungers or pistons. Such motors become extravagantly costly for low-working pressures. The greater the working pressure, the more conveniently and cheaply is the power produced by motors of this class. Hence, the general adoption of pressures of 700 to 800 lbs. per square inch in high-pressure systems. The pressure engine type of motor is extremely convenient for lifting machinery and hydraulic presses, and even for rotative motors of small size. It is not nearly so convenient when a large amount of power is to be developed continuously for driving a factory. For that purpose turbine motors are much better, being cheaper and more easily regulated. It is true that some of the newer types of turbine, such as impulse turbines and Pelton wheels, can be used even at pressures of 800 lbs. per square inch. But, on the whole, low-pressure reservoir systems are better suited to cases where power has to be developed by turbines.

High-pressure Systems.

*The Hull Hydraulic Power System.**—This was the first scheme for distributing power hydraulically to many consumers. The principal main is 6 inches in diameter and 1,485 yards in length. The joints were flanged joints, with a guttapercha ring of the kind generally used since. The pumping station is arranged for four 60 horse-power engines, of which two have been erected. Each engine delivers 130 gallons per minute at 700 lbs. per square inch pressure, corresponding to 63·6 effective horse-power. There is an accumulator 18 inches in diameter and 20 feet stroke, loaded to 610 lbs. per square inch. The charges were originally intended to be £52 for one crane per annum, and less for several cranes in one warehouse. The charges are, however, by quantity of water supplied as measured by meter. The minimum charge is £8 per machine per annum. The charge by quantity of water used ranges from £8 per annum for 16,000 gallons, or less, to £200 for 1,200,000 gallons, with special rates for greater quantities. The following short Table will give an idea of the way the charges are graduated:—

Consumption of water per quarter.	Charge per quarter.			Charge per 1000 galls. supplied.
Gallons.	£	s.	d.	Shillings.
4,000 or under	2	0	0	10·0
9,000 to 10,000	3	10	0	7·0
49,000 to 50,000	12	10	0	5·0
99,000 to 100,000	20	0	0	4·0
199,000 to 200,000	35	0	0	3·5
299,000 to 300,000	50	0	0	3·3

The charge in excess of 300,000 gallons per quarter is 2·5 shillings per 1,000 gallons. For 500,000 gallons per quarter, 2.5 shillings per 1,000 is charged for the whole supply.

*The London Hydraulic Power Company.**—An Act was obtained in 1871 for supplying hydraulic power in London. The rights conferred by the Act remained dormant until resuscitated by Mr. Ellington in 1882. The present company was constituted in 1884. In 1887, twenty-five miles of pressure main had been laid in London streets, and at the present time there are nearly sixty miles of pressure mains. These extend from the West India Docks and Wapping on the east, to Kensington on the west; from Mint-street, south of the river, to Clerkenwell and Old-street on the north.

There are three principal pumping stations—one at Falcon Wharf, a short distance east

* See Robinson, "Proc. Inst. of Civil Engineers," vol. xlix.

* The account of the London Hydraulic System is taken partly from a paper by Mr. E. B. Ellington, "Proc. Inst. Civil Engineers," vol. 94, partly from the Reports of the Company.

of Blackfriars-bridge (800 indicated horse-power); another at Millbank, Westminster (600 indicated horse-power); and one at Wapping (1,200 indicated horse-power). A fourth station, in the City-road, is in course of erection (1,200 indicated horse-power). The aggregate power of all the stations, when complete, will be 3,800 indicated horse-power, of which one-third is reckoned as reserve power, in case of repair or accident.

At Falcon Wharf and Millbank all the water is taken from the river, but it is filtered before it is pumped into the mains. At Wapping, part is taken from the London Dock, part from a well. After use by consumers it flows into the sewers. The power is available for use night and day all the year round. It is largely used for lifting machinery and for presses and pumps. The company claim that it can be used for electric lighting of particular establishments and for extinguishing fires. For this last purpose, Mr. Greathead's injector hydrant, or hydraulic intensifier, is applied; a small jet of water from the high-pressure mains is made to intensify the pressure of a larger jet drawn from the ordinary town mains. A fire stream is so obtained capable of reaching the top of high buildings without employing a fire-engine. In 1892 there were 1,696 machines worked by pressure-water from the company's high-pressure mains, consuming 6,000,000 gallons per week. The quantity of water used by each consumer is measured by a meter on the exhaust pipe of the machines driven. Parkinson's meter is most used. Siemens's turbine meter is used to some extent, but it is inaccurate under the sudden fluctuations of discharge which occur. Kent's positive meter is also used.

At Falcon Wharf there are four sets of compound pumping engines, capable of indicating 200 indicated horse-power. They are vertical, with one high and two low-pressure cylinders, and a pump plunger directly connected to each piston. At 200 feet of piston speed per minute, each set of engines will deliver 240 gallons per minute, at 750 lbs. per square inch pressure into the accumulator. This corresponds to 120 effective horse-power. A nine hours' trial of one set of engines was made in 1887, the engine running at constant speed and the coal used being Seaborne small coal. The boilers are provided with an economiser.

TRIAL OF HYDRAULIC PUMPING ENGINES.

Total indicated horse-power	178·5
Piston speed, feet per minute......	221·4
Steam pressure, lbs. per square inch	82·5
Evaporation (from and at 212°) per pound of fuel, lbs.	10·59
Feed water per I.H.P. hour, lbs. ..	19·79
Coal per I.H.P. hour, lbs.	2·19
Accumulator pressure lbs. per square inch........................	750
Effective horse-power, calculated from water pumped, allowing 5 per cent. slip.................	139
Mechanical efficiency of engine	0·78
Water pumped per minute (gallons)	265·7

The engines consume, in ordinary work, 2·93 lbs. of coal per indicated horse-power, which is greater than the result given above, in consequence of the fluctuation of speed.

There are two accumulators at Falcon Wharf, with rams 20 inches in diameter, and 23 feet stroke. Each accumulator has a capacity of storage equal to 2·4 horse-power hours. The filters are Perrett filters, constructed by the Pulsometer Company. The filtering material is compressed sponge. It is cleansed every four to six hours, by reversing the direction of flow, and by alternately compressing and releasing the pressure on the sponge.

The pumping station at Wapping is a more recently constructed and larger station than that at Falcon Wharf. The water pumped is obtained partly from a well sunk into a gravel bed, partly from the London Dock. The pumping from the well into a tank over the boiler-house is effected by low lift pumps worked hydraulically by the pressure-water. From this tank it passes through "Torrent" filters constructed by the Pulsometer Company to underground reservoirs. From this it is lifted by the condenser circulating pumps to another tank above the boiler-house, whence it is pumped into the mains. The reservoir capacity is 800,000 gallons. The engine-house contains six sets of vertical inverted triple expansion engines with cylinders 15 inch, 22 inch, and 36 inch diameter, and 24 inches stroke. Each piston drives a single acting plunger pump with ram 5 inches diameter direct from the cross-head. The working steam pressure is 150 lbs. per square inch, and the hydraulic pressure 800 lbs. per square inch. Each set of engines will deliver 300 gallons of water per minute at a piston speed of 250 feet per minute. All the cylinders are jacketed.

In a test trial, the engines are stated to have worked with 14·1 lbs. of steam, and 1·27 lbs. of Welsh coal per indicated horse-power hour. The water passes from the pumps to two

accumulators, with rams 20 inches diameter and 23 feet stroke. One of the accumulators is loaded to a slightly heavier pressure than the other, so that one accumulator rises a little in advance of the other. The more heavily loaded accumulator automatically shuts off steam when at the top of its stroke. A good description of these works will be found in *Engineering* for January 20, 1893.

Charges for Pressure-water for Power Purposes.—The London Hydraulic Company make a minimum charge of £1 5s. per quarter per machine. For consumers using more than 3,000 gallons per quarter, there are graduated charges, of which the following short Table gives a sample :—

Gallons used per quarter.	Charge. £ s. d.	Cost of Pressure water per 1,000 gallons. Shillings.
3,000, or under	1 5 0	8·3
10,000	3 10 0	7·0
50,000	12 10 0	5 0
100,000	20 0 0	4·0
200,000	31 5 0	3·1
300,000	42 10 0	2·8

For an excess over 300,000 gallons per quarter is charged at 2s. per 1,000 gallons. Consumers using more than 500,000 gallons per quarter are charged 2s. per 1,000 gallons all round. Rates are further reduced for still larger quantities, and the minimum rate is 1·5s. per 1,000 gallons.

With these charges, the cost of power for the kind of work for which an hydraulic system is best suited is small. Thus it is often less than one farthing per ton lifted 50 feet. On the other hand, it is necessary for the purpose of this treatise to consider the cost of power distributed by different methods on some common basis. It is almost unavoidable to take the cost of power exerted continuously through the working day. If the cost of power supplied by the Hydraulic Power Company is reckoned for machines working 3,000 hours per year, then the cost is larger than that of power obtained in other ways. The comparison of the cost so reckoned is instructive, although it may be, in fairness, pointed out that Mr. Ellington, in his paper, stated that he had never advocated the supply of power for continuous driving engines to any large extent.

To obtain one effective horse-power during 3,000 hours per annum, allowing an efficiency of 80 per cent. in the motor, 437,500 gallons of water are required. Hence a consumer taking 50,000 gallons per quarter would get the equivalent of 0·457 effective horse-power for 3,000 hours, and would pay for it at the rate of £109 per horse-power per annum. A consumer taking 300,000 gallons per quarter would get the equivalent of 2·743 effective horse-power for 3,000 hours, and would pay at the rate of £62 per effective horse-power per annum. A consumer taking 500,000 gallons per quarter would get the equivalent of 4·573 effective horse-power for 3,000 hours, and would pay at the rate of £43 15s. per effective horse-power per annum. It must be remembered that this is the cost for pressure-water only, and does not include meter rent or interest on the cost of the motors.

The Liverpool Hydraulic Supply System.—In Liverpool, pressure-water from the town mains was used for working hydraulic cranes as early as 1847. From an interesting paper by Mr. Joseph Parry* it appears that the use of hydraulic power in this way made very slow progress. In 1877 the number of hydraulic machines supplied from the town mains was 89. At the present time there are 162 machines worked by water from the town mains, consuming 125,600,000 gallons per annum. Taking the mean pressure at 70 lbs. per square inch, this is equivalent to 82,710 effective horse-power hours, or to 27 effective horse-power for 3,000 hours in the year, a rather insignificant amount. The average charge for working a goods hoist is £13 per hoist per annum, or only 10d. per hoist per day, a small cost for the convenience afforded. The charge for water is 7d. per 1,000 gallons. At this rate the charge is equivalent to £120 per effective horse-power per year of 3,000 hours. Experiments on the quantity of water used by some hoists showed the cost to amount to from 6d. to 10d. per ton lifted 50 feet.

There is also in Liverpool a high-pressure system, which is to be extended. Experiments with some hoists worked on this system showed the cost to be from 1¾d. to 2¼d. per ton lifted 50 feet. Mr. Parry comes to the conclusion that hoists worked from the town mains cost more than those on the high-pressure system

* "The Supply of Power by Pressure from the Public Mains." "Proc. Inst. of Mech. Engineers."

when the charge for water on the high-pressure system does not exceed 5s. per 1,000 gallons.

The Birmingham Hydraulic Power System.—In Birmingham, as in Liverpool, water has been supplied from the town mains to work lifts. In 1888 there were 61 lifts and hoists thus worked, using 80,000 gallons per day, and yielding to the Water Committee of the Corporation about £1,000 a year. Since that time a high-pressure system has been carried out, which has the peculiarities, that it belongs to the Corporation and that the pumping is done by gas-engines.*

At the pumping station there are three sets of triple hydraulic pumps, working to a pressure of 730 lbs. per square inch. These are driven by three Otto gas-engines, nominally 12, 20, and 20 horse-power, but capable of developing an aggregate of about 100 horse-power. Ordinary lighting gas is used. The pumps deliver into two 6-inch mains. There are two accumulators, with 20-inch rams and 20 feet stroke. A small Brotherhood engine, worked by the pressure-water, is used in starting the gas-engines.

Manchester Hydraulic Power Supply.—At Manchester a combined scheme for supplying electricity and high pressure-water is being carried out. A pressure of 1,000 lbs. per square inch in the hydraulic system is to be used. It is hoped that there will be economy in working the electricity and pressure-water supply from the same station.

Low-pressure Hydraulic Systems.

The Zurich Works.—The Zurich installation is a complex and very interesting one.* It was the earliest example in Switzerland of the application of hydraulic power, partly to pump a supply of potable water, partly to furnish motive power from the same central station. It has grown gradually, and of late has been greatly extended. It comprises machinery driven by turbines for furnishing (*a*) a water supply to the town of Zurich; (*b*) a supply of motive power transmitted by wire rope; (*c*) a supply of motive power transmitted by comparatively low pressure water from the town mains; (*d*) a supply of motive power transmitted hydraulically from a special reservoir at comparatively high pressure; (*e*) an electric central station also driven by water-power.

* See *Engineering*, February 12, 1892.

* See Preller on "The Zurich Water Supply Power and Electric Works." "Proc. Inst. Civil Engineers," vol. cxi.

When the works were first established the water supply of Zurich was obtained from a filter in the bed of the River Limmat, near its exit from the lake. This water was pumped by turbines erected a little further down stream. There being surplus water-power, a telodynamic transmission was erected, and part of the motive power was distributed to factories along the riverside. In 1884 the quality of the water was found to be inferior. After extensive investigations, it was decided to obtain a new supply of potable water from an intake in the lake, and to use the old water supply for motive power purposes only.

The fall available in the Limmat at the pumping station, and the available volume of flow, are as follows:—

	Fall.	Volume of water flowing in the river.	Gross water H.P.
	Feet.	c. ft. per sec.	H.P.
High water level in summer...	4·92	2,295	1,300
Mean „ „ „ ...	8·20	1,660	1,570
Low „ „ winter ...	10·50	1,059	1,280

The effective power delivered by the turbines in the river is as follows:—

	H.P.
For pumping filtered potable water..	237
Supplying motive power by pressure-water........................	128
Driving the wire-rope transmission ..	227
Supplying hydraulic motive power for electric lighting station	444
Total	1,036

There are two reserve steam-engines of 300 indicated horse-power each, to provide for a deficiency of water-power.

At the pumping station there are eight pressure (Jonval) turbines, working up to from 96 to 100 horse-power, according to the state of the river. There are, also, two newer turbines, of about 175 horse-power each. The turbines have vertical shafts, and each pair drives, by bevil wheels, a common horizontal shaft, which runs at 50 revolutions per minute, in the case of the earlier turbines, and at 66 revolutions per minute in the case of the two last erected. From these shafts a horizontal main shaft, 328 feet in length, and running at 100 revolutions per minute, is drawn. To this main shaft any of the pumps may be coupled. The earlier turbines cost, with gearing, about

£12 per horse-power, the two larger turbines about £7 per horse-power. There are at present in operation seven sets of horizontal double-acting Girard pumps. The total pumping capacity is 8,143,000 gallons per day. The water for driving the turbines is obtained by a weir in the Limmat, which deviates the water into a canal formed by a longitudinal embankment in the river. Sluices divide the head race channel from a tail race channel formed in a similar way. The pumps supply the following reservoirs :—

	Height above Pumps.	Capacity in Cubic Feet.	
		Present.	To be increased to.
Low level	154	205,000	—
Intermediate level	300	68,500	141,000
High level......	485	10,600	21,190
Reservoir for high-pressure power-water	528	353,170	529,000

From the town mains water is supplied to work 180 small motors. The total power thus supplied is about 187 horse-power, and its cost is about 4·4d. per horse-power hour. The principal supply of power, apart from that distributed by wire-rope, is obtained from pressure-water obtained from the old Limmat filter bed, and pumped to the special high-level reservoir. This water is pumped chiefly during the night. The reservoir is about 6,000 feet from the pumping station, and is supplied by an 18 inch main. The effective pressure at the motors is about 475 feet, and the distributing mains have an aggregate length of 15,000 feet. The charge for this pressure-water for power purposes varies from 0·6 pence per horse-power hour, when at least 50,000 horse-power hours are taken in the year, to 1·25 pence per horse-power hour, when less than 20,000 horse-power hours are taken in the year. For 3,000 working hours in the year, the charge is from £7 10s. to £16 per horse-power per annum. The water supplied in this way now amounts to 42,380,000 cubic feet per annum, yielding altogether about 900,000 horse-power hours. The total receipts are £1,200 per annum, or 1·08d. per 1,000 gallons.

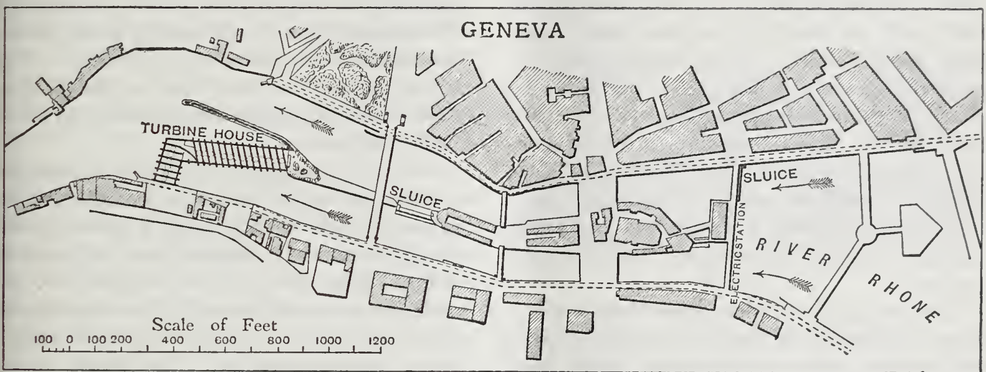
Besides this supply of pressure-water to various consumers, the electric station is ordinarily to be driven by pressure-water from the same high level reservoir. For this purpose two impulse turbines of 300 horse-power each have been erected for driving dynamos, and two smaller turbines of 30 horse-power driving exciting dynamos. Alternatively if the supply of pressure-water fails, the dynamos can be driven by the river turbines or by the reserve steam-engines.

The Hydraulic Works and System of Hydraulic Power Supply at Geneva.—There is now in operation at Geneva one of the most remarkable hydraulic power stations in the world. The water of the River Rhone, near the point where it flows out of Lake Leman, is employed to drive a number of large low-pressure turbines, giving a total of 4,500 effective horse-power. These turbines pump pure water obtained from the lake into two systems of mains. The older of these, termed the low-pressure system, the pressure at the pumps being 160 to 200 feet, is an extension of a previously existing system of mains used for supplying potable water to the town of Geneva. Although some of the water pumped into this system is used for power purposes, it is chiefly intended to supply water for domestic and municipal purposes. The second system of mains, termed the high-pressure system, the pressure at the pumps being 460 feet, supplies potable water to some districts not reached by the low-pressure system, but it is specially intended to afford a supply of water for motive power purposes to the entire area of the town. The demand for water, both on the low and high-pressure system is a fluctuating demand, large during the day, and very small during the night. Hence if the turbines in the Rhone were employed solely in pumping into the mains, they would not be continuously working, and a large part of the water-power of the Rhone would be wasted. To meet this difficulty, an important storage reservoir has been constructed at Bessinges, about 4 kilometres from Geneva. The turbines pump water up to this reservoir at night, and at times when the demand for power for other purposes is insufficient to keep them fully employed. The energy derived from water flowing back from the Bessinges reservoir through the high-pressure system, represents parts of the water-power of the Rhone which would necessarily have been wasted if this means of storage had not been provided.

The works at Geneva have been gradually developed under special local conditions. In spite of natural and political isolation, manu-

facturing industries have for centuries flourished at Geneva. That they did so is partly owing to the fact that cheap water-power could be obtained by simple forms of water-wheel placed in the ample and rapid Rhone, flowing past the town. An industrial quarter gathered along the banks of the river, and factories were built even in the stream itself. As the population increased, a water supply was required. The small aqueducts of spring water became insufficient, and further recourse was had to the motive power of the Rhone. From the beginning of the 18th century, water-wheels placed in the Rhone pumped a water supply into the town.

Then arose an antagonism to the utilisation of the motive power of the Rhone, which, for two centuries, hindered the progress of industrial enterprise at Geneva, and threatened at times to destroy the existing industries. The properties of riparian owners on the shores of Lake Leman were from time to time injured by the rising of the lake level. It was not unnatural that the landowners should attribute the disastrous inundations from which they suffered to the obstacles created at the outlet of the lake, that is to the bridges and buildings, and especially the factories and water-wheels in Geneva. Complaints were addressed by the Canton Vand to the Federal Government at Berne of damage caused by the works at Geneva. Then arose a question of arrangements necessary to regulate the lake level, and to facilitate in time of flood the discharge of the water. From 1875 the project of utilising the motive-power of the Rhone took a new magnitude and importance from the combination with it of plans for regulating the level of Lake Leman, and so ending a long and bitter controversy.



Walker & Boutall sc.

FIG. 21.

Another local circumstance had great influence in determining the ultimate form of the project for the utilisation of the motive power of the Rhone. In 1871, Col. Turrettini*, the engineer under whose direction the present works have been constructed, had applied to the Town Council of Geneva to place small pressure engines on the mains of the then existing low-pressure water supply. The plan of obtaining motive power in this way proved so successful and convenient that, in 1880, there were 111 motors at work, using 34,000,000 cubic feet of water annually, and paying a yearly rental for power-water of £2,000. The cost of the power at that time to consumers was at the rate of £36 to £48 per horse-power per year of 3,000 working hours.

In 1878, a private firm asked the concession of a monopoly of the motive power of the Rhone, at Geneva, on condition of carrying out works necessary for facilitating the discharge from the lake, and regulating the lake level. A similar offer was made in 1881. But there grew up a feeling that such works should be carried out by and for the profit of the town itself. Finally, after many studies the contract was given by the Municipality in 1883 to M. Chappuis to construct under their direction the present works.

These works have cost, altogether, £283,000. Of this sum, a fraction has been paid by owners of land on the shores of the lake and part has been expended in constructing new sewers required in consequence of the alterations of river level. Deducting these items, the cost of utilising the motive power of the Rhone has already amounted to nearly £200,000.

The scheme included the clearing away of

* "Utilisation des forces motrices du Rhone et régularisation du lac Leman." Th. Turrettini, Ingenieur Conseiller Administratif délégué aux travaux. Geneva, 1890. This admirably illustrated memoir fully describes the origin, progress, and details of all the works at Geneva.

all obstacles to the free flow of the river, and the division of the river, by a longitudinal embankment, into two portions, one forming a head-race to the turbines (Fig. 21), the other —which was straightened and deepened—forming an outlet for the surplus water from the lake. Between the two divisions of the river bed are movable sluices, which keep up the water in the head-race channel, or discharge surplus water into the tail-race channel, according to the condition of the lake. The scheme also included a complete re-construction of the old pumping system for the low-pressure water supply, the creation of the new system of high-pressure water supply, and the provision of motive power by hydraulic transmission to the industries of the town.

The Low-pressure River Turbines.—The turbine and pump-house is placed at the end (Fig. 21) of the left-hand channel or head race. The turbines are of 210 horse-power each, and 14 groups of turbines and pumps have been erected. Four more groups, of somewhat greater power, are expected to be erected within the next five years. The turbines are Jonval pressure turbines, constructed by Messrs. Escher, Wyss and Co., of Zurich. They have vertical shafts, and each turbine drives from a crank two horizontal double-acting Girard pumps, placed at right angles.

The head at the turbines varies from 5·5 feet, when the river is in flood, to 12·14 feet when the volume of flow is smallest. With most forms of turbine this would involve a considerable variation of the normal speed, or speed of greatest efficiency. The turbines are skilfully arranged to meet this variation of head. The turbine wheel and its corresponding system of guide passages is arranged in three concentric rings. When the fall is great, and the quantity of water used is smallest, the outer ring only is open, and the water acts at a large radius. As the fall diminishes, the second ring is opened, and the mean radius, at which the water acts, is smaller. In the lowest condition of the fall, when most water must be used, all three rings are open, and the mean radius at which the water acts is smaller still. The number of rotations of the turbine depends entirely on the velocity due to the head and inversely on the radius at which the water enters. Hence, as the radius diminishes as the head diminishes, a fairly constant speed of rotation is obtained. The adjustment is such that, with the highest fall, the normal speed is 27 revolutions per minute, and with the lowest fall, 24 revolutions per minute, a variation not practically serious in working pumps.

The fixed distributor over the turbine wheel is 13·78 feet in external diameter and 5·74 feet in internal diameter. It is divided into three rings, having 52 guide passages in the outer ring, 48 in the middle ring, and 40 in the inner ring. The external ring has no regulating sluices, regulation being effected, when that ring only is open, by the sluices in the head race. The other rings are arranged so that over one semicircle the orifices open vertically on an annular plane surface, and over the other semicircle they open horizontally on a cylindrical surface. Each ring of passages has two regulating sluices, one a semicircular annular plate for the orifices opening vertically; one a semi-cylinder for the openings which are horizontal. Each sluice can be fully opened without interfering with the openings corresponding to the other. The sluices are worked by gearing. The turbine wheel is of cast iron, in two halves. It has wheel passages corresponding to those in the distributor.

The vertical support of each turbine consists of a fixed wrought-iron pillar, carrying at its top a steel step for the pivot, and a steel revolving hollow shaft hanging from the pivot at the top. The pivot is 6 inches diameter. A crank at the top of the shaft drives two Girard double-acting pumps placed at right angles from a single crank-pin. The Girard pump consists virtually of two plunger pumps placed end to end, the advantage being that the stuffing-boxes for the plungers are accessible and there is no internal packing. The two pumps discharge into a single air-vessel placed between them. The diameter of the plungers of the low-pressure pumps is 1·41 feet, that of the high-pressure pumps 1·08 and 0·85 feet. The stroke is 3·61 feet, and the mean velocity 188 feet per minute. The valves are ring valves with leather faces. The high-pressure pumps supply mains of 20 inch diameter, and of 24 inch and 16 inch in the other. The low-pressure pumps supply two mains of 20 inch diameter.

The High-pressure Reservoir at Bessinges.—When the high-pressure system was first put in operation, a constant pressure was maintained in the mains, by constantly pumping in excess of the demand, and allowing the surplus to flow away through a relief valve. This involves a constant waste. To further moderate fluctuations of pressure, four large air-vessels

(additional to those at the pumps) were erected. These were 5 feet in diameter, and 39 feet high, and were kept charged with air by a Colladon compressor. When it became a question of driving the electric station by turbines driven by water from the high-pressure system, the need of a storage reservoir became pressing. At four kilometres from Geneva a site was found, at an elevation of 390 feet above the lake, and it was decided to construct a reservoir capable of storing the discharge of three groups of pumps working through the night. The discharge of the pumps is 34,000 cubic feet per hour, or 442,000 cubic feet per 13 hours, during which, if there were no means of storage, they would be put out of action.

The reservoir is a covered reservoir, capable of containing 453,000 cubic feet. It stores, therefore, 5,573 gross horse-power hours of energy. Allowing for the loss at the motors driven by the pressure-water, the reservoir will furnish about 800 effective horse-power for five hours. It serves as a perfect regulator of pressure. A float with electric signal and recording apparatus shows constantly in the pump-house the condition of the reservoir.

Hydraulic Pressure Relay or Compensating Pressure Regulator.—The 16-inch pipe main from the pumping station to the reservoir at Bessinges being four kilometres in length, there would be a difference of pressure in the mains in Geneva equivalent to the friction of eight kilometres of main, according as water was being pumped up to or flowing back from the reservoir. This would not have been very serious if all the motors driven by the water had been supplied by meter. But the larger motors are supplied by gauging, the quantity of water used being computed from the area of the orifices of discharge. Variations of head would have involved a variation of the quantity of power developed at the motors amounting to 20 per cent. This would have hindered the development of that method of estimating the charge for water.

To prevent this variation of head, Col. Turrettini devised a centrifugal pump relay, shown diagramatically in Fig. 22, which comes into action automatically, and increases the pressure whenever the water is returning from the reservoir to the town. The centrifugal pump, which forms part of the main, is driven by a turbine so regulated for speed that a constant pressure is obtained on the town side of the pump. The pump receives, at the maximum, 635 cubic feet of water per minute, and can give to the stream passing through it an increase of pressure of 30 feet. The turbine works with 380 feet of head, and can exert 120 horse-power.

The sluices of the turbine are governed by an automatic pressure regulator. The pressure in the main acts on a piston controlled by a spring. According to the position of the piston, the turbine sluices are open more or less. The movement of the piston actuates the valve of an hydraulic relay which operates the turbine sluices. During the filling of the reservoir the centrifugal pump is at rest, the water merely flowing through it. When water flows back from the reservoir the turbine begins to drive the pump so as to increase the pressure in the main. The arrangement has worked with perfect success.

The Motors used in Geneva.—The original motors used in Geneva were Schmid pressure engines, and these are still used for small powers. They use a quantity of water which depends on the speed only and not on the work done. Hence they are uneconomical with light loads. They are convenient and cheap, they can be run at any speed, and they act as meters of the quantity of water used. A counter on the pressure engine recording the number of revolutions, gives the means of ascertaining accurately the quantity of water used. At full load their efficiency is 80 per cent.

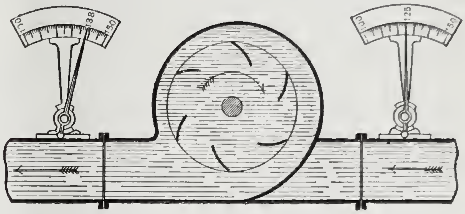


FIG. 22.

For all larger motors impulse turbines are used. The maximum efficiency of these is 75 per cent., and it is not much less with light loads. They occupy little space, and can be perfectly governed to constant speed by the ingenious relay governors of Messrs. Faesch and Piccard. In Geneva the question of speed regulation was found to be an important one. The industries connected with watchmaking required motors running at constant speed.

The Electric Lighting Station.—In 1887, the City Council came to an arrangement with a company for supplying electricity. It was

part of the arrangement that the company should use pressure-water, supplied by the town, as motive power in all its installations. The pressure-water is supplied to the company by meter, at a price of two centimes per meter cube, with a minimum of 400,000 cubic metres annually. This is equivalent to a little more than £3 per effective horse-power per annum. The advantage to the town is that their pumping machinery can be run constantly, night and day, the energy, which would otherwise be wasted, being stored. The electric company, on the other hand, get power at a cheap rate, and their turbines being driven by high pressure, are convenient and cheap, and run at an extremely constant speed.

Under the arrangement an electric station has been installed in the old pumping station, no longer required for its original purpose (see Fig. 21). There are three impulse turbines of 200 horse-power each, and each turbine drives two dynamos directly coupled to it by Raffard couplings. There is also a 25 horse-power turbine and dynamo for day work. It is the system of reservoir storage which makes this hydraulic driving of the dynamos possible and economical. They could not be driven so conveniently by the large low-pressure turbines in the river, with the very varying head which they have to utilise, nor could power be spared to drive them, except by utilising the motive power of the flow of the river through the night.

Obituary.

Lord Alfred Churchill.—The death of Lord Alfred Churchill at his residence, 16, Rutland-gate, on Thursday, 21st inst., has deprived the Society of Arts of one who for many years was a most active member, and twice held the office of Chairman of Council. He was elected a member in 1862, and first came on the Council in 1872. From 1875 to 1879 he held the office of Vice-President. He was again elected a member of Council in 1881, and continued such until he again became a Vice-President in 1883. With the exception of the years 1887 and 1888, he held the latter office until the present time. He was Chairman of Council in the years 1875-76 and in 1878-80, when he was most earnest in his endeavours to promote the prosperity of the Society; and at the annual meeting in 1880, a special resolution of thanks was passed to him on his retiring from the office. He was a constant attendant at the meetings of the Society, and frequently presided. During the last few years, however, his health necessitated his residence at Brighton, and he has not, therefore, been so much seen in London. As a member of the Council, Lord Alfred was also a member of the Royal Commission for the Chicago Exhibition. He acted as one of the General Committee of the Health Exhibition, 1884, and was also a member of the Committee of the Paris Exhibition of 1889. Lord Alfred Spencer Churchill was the second son of George, sixth Duke of Marlborough, and was born 24th April, 1824. He was appointed Lieutenant 83rd Foot in 1847, and retired in 1848. In 1857, he became Major Oxfordshire Yeomanry Cavalry and Lieutenant-Colonel in 1860. He was member of Parliament for Woodstock from December, 1845, to July, 1847, and from July, 1857, to July, 1865. For several years he held the offices of director and deputy-chairman of the East London Railway, In 1857, he married Harriet, third daughter of Frederick, fourth Lord Calthorpe, who survives him. The death of Lord Alfred Churchill will be keenly felt by the large circle to whom he was known, and the Society of Arts has lost in him a warm friend, who took the liveliest interest in its welfare. Lord Alfred Churchill had been seriously ill during the last few months, and for eight weeks he never left his bed. He passed away calmly and peacefully in his sleep.

Thomas Hawksley, F.R.S.—Mr. Hawksley, the distinguished civil engineer, who died on Saturday, 23rd inst., held the office of Vice-President of the Society of Arts from 1888 to 1892. He was elected a member in 1868, and took part on several occasions in the proceedings of the Society at the evening meetings. Mr. Hawksley was born at Nottingham in 1807, and was appointed to construct the waterworks of his native town about the year 1830. He did not remove to London until 1852, but he at once took a prominent position as a hydraulic and drainage engineer. During his life he is said to have constructed above 150 waterworks, many of the largest character. He is entitled to the honour of being the first to suggest and to carry into practice the system of "constant service" in water supply. Mr. Hawksley joined the Institition of Civil Engineers in 1840 and was elected President in 1871. He was also President of the Institution of Mechanical Engineers in 1876-7, and one of the founders and first president of the Gas Institute. In 1878 he was elected a Fellow of the Royal Society. The details of Mr. Hawksley's distinguished professional career are so well known, and have been so fully detailed in *The Times* and other newspapers, that it is not necessary to repeat them here, but it may be mentioned that, on his attainment of the age of 80, in 1887, his many friends subscribed to present him with his portrait, painted by H. Herkomer, R.A. The presentation took place on his birthday, and it was announced in an address by Sir Richard Webster, who was then Attorney-General.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

HOWARD LECTURES.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.

By Prof. W. Cawthorne Unwin, F.R.S.

Lecture V.—Delivered February 10, 1893.

Transmission by Compressed Air.

Compressed air has been employed in engineering operations for a long period. The earliest important application was the diving bell. This is believed to have been used in the 16th century. Smeaton, in 1786, and Rennie, in 1812, used diving bells and air-compressors in important operations. Subsequently, compressed air was applied in sinking bridge piers. Cubitt employed compressed air in sinking the piers of Rochester-bridge, in 1851; and Brunel a similar process at Saltash in 1854. Compressed air was applied in driving the Thames Tunnel by Brunel, and in driving the Thames Subway, by Barlow. It has been used since in several similar works of a difficult character. The shaft of the Marie Colliery, at Seraing, was sunk by means of compressed air, by the firm of John Cockerill, in 1856.

The application of compressed air, as a motive power in transporting goods, seems to have been first suggested by Medhurst, in 1810, and by Vallance in 1818. Some early pneumatic railways were built; later, similar methods have been revived in the systems for transmitting messages and parcels through pneumatic tubes in London and Berlin.

Papin appears to have considered the transmission of motive power to a distance by a vacuum method in 1688. Triger actually transmitted motive power by compressed air a distance of 750 feet at the mines of Chalonnes in 1845. Soon after, compressed air was used in several collieries. The greatest impetus to the application of compressed air as a means of distributing power resulted from its employment in working boring machinery in tunnels. Brunton, in 1844, suggested this application, and, in 1852, Prof. Colladon of Geneva proposed the use of compressed air in the construction of the Mont Cenis Tunnel. It was, perhaps, at Mont Cenis that compressed air was first used for motive-power purposes on a large scale. M. Sommeiller, in association with M. Kraft, made extensive experiments at the works of John Cockerill at Seraing, and with the data so obtained, the whole of the machinery for compressing, transmitting, and utilising compressed air at Mont Cenis, was designed and constructed at Seraing. At first, for compression, a kind of hydraulic-pneumatic ram was used. In 1861 this was superseded by water-piston compressors, driven by turbines. The air was transmitted a maximum distance of 20,000 feet to work the drills. The air pressure used was seven atmospheres (105 lbs. per square inch). There were at Mont Cenis air-motors worked expansively, the cylinders of which were heated externally to prevent freezing. In the construction of the St. Gothard Tunnel, in 1872, still more powerful air-compressing machinery was employed. The compressors were at first designed to be of small size, to run at a high speed, and to be cooled externally; but with a short stroke and quick speed there is not time for the heat developed by compression to be abstracted through the cylinder wall, and a spray injection, suggested by Prof. Colladon, was added.

In 1877, Mekarski used air compressed to 25 or 30 atmospheres, in conjunction with a small amount of high-pressure steam, to drive tramway cars, and he was one of the first to use compound compressors.

In 1877, at Vienna, and in 1881, at Paris, M. Popp installed a system for working and regulating a great number of clocks by impulses of compressed air conveyed in pipes from a central station. A demand arose for a supply of the compressed air for working small motors, and this proved so successful that there has been developed in Paris the most important system of power distribution hitherto carried out. In Paris, motive power is transmitted to industries of every kind over a large area by air compressed at a central station, and even sub-stations for electric lighting are driven by air motors. It is interesting that in Paris a system of distributing motive power by vacuum

carried out by M. Boudenoot, has been successfully in operation since 1885. The motors are worked by atmospheric pressure and exhaust into pipes, in which a vacuum is maintained by air-pumps at a central station. A system of pumping sewage at a number of scattered sub-stations by compressed air supplied from a single compressing station, has been developed by Mr. Isaac Shone, and is in operation at several towns in this country and the United States, and at Rangoon.

Compressed air transmission is a perfectly general method of distributing power for all purposes. Whether, in any given case, it is the most advantageous, the least wasteful of power, or the cheapest in working cost, depends on various circumstances. M. Hanarte believes that it is—and will continue to be—the most economical method of transmission to considerable distances.* The loss in the air mains is very small. The motors worked expansively are efficient. The mains can be carried by any path, and differences of elevation between the compressing and working points do not sensibly affect the result. In hydraulic transmission the water must be collected, stored, and in some cases filtered; and having actuated a motor, means must be found for removing it. But air is everywhere available, and can be discharged anywhere without causing trouble. Compressed air has peculiar advantages in the case of underground transmissions. It has been used to replace manual labour in situations where hardly any other motive power could have been employed. In driving a tunnel at a mine at Sacramento, for instance, the cost was reduced to one-half, and the rate of boring was three times as fast when compressed air machinery replaced hand-labour. In such cases the advantage is so great, even with uneconomical machinery, that the inducement to adopt very perfect machinery is absent. Hence much of the air-compressing plant at mines has been unnecessarily inefficient and wasteful of power. In many cases, air-compressing plant has been driven by water-power, and this also has tended to a neglect of the conditions necessary for economical working. Mr. Savage argues, with reference to the Terni Steel Works,† that the common objection to the use of compressed air on the ground of waste of power, loses much of its force when the compressors are worked by an almost costless supply of natural energy such as water-power. It is unfortunate for the reputation of the system of transmission by compressed air that the rough purposes to which it has been applied, the indifference to waste of power in mining and tunnelling operations, and the preference for simple and cheap machines, has delayed and hindered the improvement of compressed-air plant.

A good deal was done to improve air-compressors by Sommeiller, by Dubois and François, and by others in the large plants constructed for Mont Cenis, for the St. Gothard works, and for some collieries. In the distribution of power in towns still further consideration has been given to the question of economy of working. But here again it has been very unfortunate that in both the great installations in Paris and in Birmingham, there were conditions of development very unfavourable to the complete and fair trial of compressed air as a means of transmission. It is reasonably certain that with greater attention to scientific principles better results are attainable than have hitherto been reached in the use of compressed air.

For the special purposes to which power distribution is applied in London, the high-pressure hydraulic system has great advantages. Where local conditions permit the construction of high-level reservoirs, a system like that in Zurich and Geneva of hydraulic distribution is perfectly successful; but, in more numerous cases, compressed air is likely to prove preferable to hydraulic transmission. It is also the most important rival of electrical distribution. There are at present extremely few cases where electrical distribution of power has been carried out; and, though enough is known of the capabilities of electrical transmission to show that it could be adopted on a large scale with complete mechanical success, the cost of the distribution of power by electrical methods is at present very imperfectly determined. For long distance transmission, and where cheap overhead conductors can be adopted, no doubt electrical methods have an important field of application; but, up to the present time, and excluding transmissions for lighting, an enormously greater amount of power has been actually distributed by compressed air than by electricity. So far as can be judged at present, in the case of distribution of power in towns, and especially where work has previously been done by steam-engines which can

* "Transmission du travail à distance, par l'air comprimé." Congress International de Mecanique Appliquée. Paris, 18 3.

† Terni Steel Works. Savage, "Proc. Inst. Civil Engineers," vol. xciii.

be converted into air motors, in such cases compressed air is likely to prove a more convenient and cheaper means of power distribution than electricity.

General Considerations on Compressed Air as a means of Distributing Power in Towns.—The desiderata in a system of power distribution in towns may be shortly enumerated as follows:—

(1.) The possibility of indefinitely subdividing the power distributed and measuring the supply to each consumer.

(2.) Minimum first cost of distributing mains, and minimum loss of energy in distribution.

(3.) Simplicity, cheapness, and efficiency of the motors required by consumers of power; and, especially, it is important that the motors should require little attendance and involve little risk.

(4.) Freedom from danger to life or property when accidents occur to motors or distributing mains.

(5.) Facility of adaptation to various requirements additional to the supply of motive power. This is important, both from the additional revenue obtained, and because the more various the applications satisfied the better are the conditions of working at the central station. The fluctuations of demand are diminished and the load line improved.

A compressed-air system meets these conditions on the whole more completely than any other system hitherto carried out. Experience in Paris shows how great the facility is for sub-dividing the power in a compressed-air system. There are motors ranging from 150 horse-power to less than one-tenth of a horse-power (45 foot lbs. per second). The majority of the air motors are in fact of less than one horse-power. These can be started and stopped by merely opening or closing the supply valve, and the measurement of the air used presents no practical difficulty. In Paris and in Birmingham the air is measured by meters, which are not costly, and which are accurate enough to give satisfaction. As to the distributing mains, it may be pointed out that in an air system no return main is required, the air being discharged at the working point without creating any nuisance. In a steam distribution a return main is desirable to avoid heat loss, and in an electric distribution a return main is necessary. Air mains are less costly than hydraulic mains or steam mains. Under what conditions they are less costly than electric mains is a question yet to be determined. Probably they are much less costly than electric mains, except in cases where high electric pressure can be used, and overhead conductors. M. Solignac has considered the case of the transmission of the 70,000 horse-power from Billancourt to the Place de la Concorde, at Paris, a distance of 4¼ miles.* He comes to the conclusion that air mains would cost £112,000, while electric mains, worked at 2,000 volts, would cost £700,000. Even if the energy were required at the terminus in the form of electricity, he concludes that it would cost 20 per cent. less to transmit by compressed air, and generate electricity at the terminus by dynamos driven by air motors, than to generate and transmit the electricity from Billancourt. As to loss of energy in the mains, electricity has little advantage over compressed air. The pressure loss in the mains of a town distribution is insignificant. In the Paris system the principal mains have an extension of 55,000 metres (34 miles). The loss of pressure between St. Fargeau and the most distant point of the main rarely reaches 8 lbs. per square inch. The safety of an air main is obvious, and even a leakage or burst of the main is much less serious, and attended with less damage, than that of a water or a steam main. Air leakage is less dangerous than electric leakage. When an air distribution is introduced in a town, power users do not require new plant, and need incur no outlay for motors. The boilers—with all their attendant disadvantages of stoking, removal of ashes, cleaning, and risk of explosion—are dispensed with, and the steam-engine, with little alteration, serves as an air motor. If an electric system is introduced, the old motors must be removed and new motors purchased. Further, if electric motors are themselves of high efficiency, they run at a high speed, and in most cases there is a considerable loss in the gearing required to adapt them to ordinary purposes. For small power users there are rotary motors of simple and cheap construction. Lastly, air motors are so simple that they require when working extremely little attention.

In regard to adaptability to various requirements, compressed air is in a very advantageous position. Electricity supplies power and light, but it cannot be used for supplying

* Solignac. "Transport de l'energie par l'air comprimé." Congress International de Mecanique Appliquée. Paris, 1893.

heat except at a cost prohibitive in most applications. Gas supplies heat, and power, and light, but, for lighting, it is open to obvious objections, and for heating and power it is expensive. Pressure-water supplies power, and, indirectly light, if a motor is used to drive a dynamo; but, except where cheap water-power is the original source of energy, it is too expensive for most purposes where motive power is required. Steam supplies heat, motive power, and, indirectly light, if a steam motor is used to drive a dynamo; but it is more expensive than compressed air, and involves more risk and attention.

Compressed air can be supplied so cheaply, that not only can it be used directly as a source of motive power, where that is the commodity required, but it can be advantageously used to drive sub-stations and private installations for generating electricity, for lighting purposes, or for working pumps and ventilating fans. With a water cushion between the air and the lift ram, compressed air is as convenient for working lifts as pressure-water. It has been used in working cranes at the Cockerill works for 20 years. Compressed air is not directly a source of heat, but used for blowing purposes it is an extremely useful adjunct to furnaces. In Birmingham, smiths' fires and cupolas have been worked direct from the air mains without any blowing machinery. A small jet of high-pressure air induces a large stream at lower pressure. In Paris, compressed air has important applications for refrigerating purposes. Besides large refrigerating stores in some restaurants, an air motor is used for driving a dynamo for lighting purposes, and the cooled exhaust from the air motor is used to cool chambers in which food is stored. Lastly, compressed air is already used in working tramways, and it appears likely that much larger applications of this kind are possible.

General Arrangement of a System of Compressed-air Transmission.—The arrangements include:—(1) A compressing plant driven by steam or water-power with air reservoirs of more or less capacity to diminish momentary fluctuations of pressure. The compressors usually require the addition of cooling arrangements for absorbing the heat developed in compression. (2) A system of air mains for distributing the compressed air to the working points. (3) Air motors driven by the compressed air and sometimes provided with reheaters to increase the work done by the air and diminish the cooling during expansion. It is necessary therefore to consider the construction of compressors and their efficiency; the construction of mains and the losses in transmission; and the construction of air motors and their efficiency.

Action in a Compressor.—Consider for simplicity a compressor which receives and discharges 1 lb. of air per stroke, and let Fig. 23 be its indicator diagram. Let P_a V_a

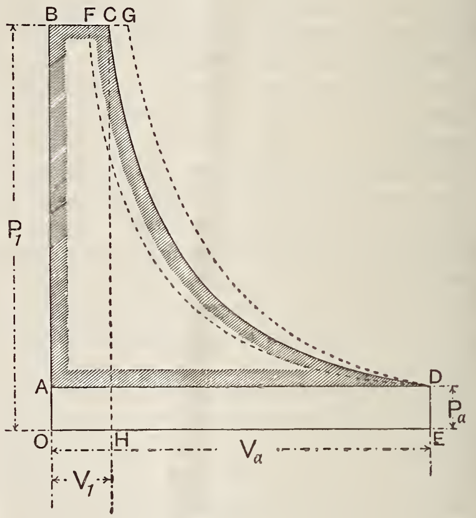

FIG. 23.

T_a be the pressure in lbs. per square foot, volume in cubic feet per lb., and absolute temperature of the atmospheric air to be compressed P_1 V_1 T_1 the corresponding quantities for the air after compression. The quantity $R = V_a / V_1$ is called the ratio of compression.

The compressor in the suction stroke draws in a volume, V_a of air at the pressure P_a, compresses it according to some law expressed by the compression curve D C to the volume V_1 and pressure P_1, and finally expels it into the mains. In general, the compression curve D C will be between two curves, D F, D G, corresponding to two limiting cases. If heat is abstracted from the air during compression, so that the temperature remains constant, the compression curve will be the isothermal D F, defined by the relation—

$$PV = \text{constant.}$$

If no heat is added or subtracted during compression, the temperature of the air will rise, and the compression curve will be the adiabatic, D G, defined by the relation—

$$PV^{\gamma} = \text{constant.}$$

In ordinary compressors the compression curve lies between D F and D G, and the tempera-

ture of the air after compression, T_1 will be greater than the initial temperature T_a.

If the compressed air were used in a motor directly adjacent to the compressor in its heated state, there would be no necessary loss due to heating during compression. But commonly the air is used at a distance, and has cooled from the volume BC to the volume BF, and from the temperature T_1 to the temperature T_a before it reaches the working point. The most economical compression therefore for a system of compressed-air transmission would be isothermal compression. The area, FDC, represents work expended in the compression in heating the air which is wasted before the air is used.

It can be shown that the work wasted in heating the air in the compressor above its initial temperature when the expansion curve is given by the relation

$$PV^n \quad \text{constant}$$

is given by the expression

$$27710 \left\{ \frac{n}{n-1} \left[\left(\frac{P_1}{P_a} \right)^{\frac{n-1}{n}} - 1 \right] - \log_e \frac{P_1}{P_a} \right\}$$

which gives the work wasted in foot-pounds per pound of air.

WORK LOST DUE TO HEATING IN COMPRESSOR.

$\frac{P_1}{P_a}$	P_1 = pressure of compression in lbs. per sq. in. (absolute.)	Work lost in adiabatic compression $n = 1{\cdot}41$	Work lost in partially cooled compression $n = 1{\cdot}25$.
2	29·4	0·077 $P_a V_a$	0·052 $P_a V_a$
4	58·8	0·322 ,,	0·209 ,,
6	88·2	0·562 ,,	0·363 ,,

It will be seen that the loss increases rapidly, almost as the square of P_1/P_a. This rapid increase of the heating loss has led many constructors to advise the use of very low working pressures in compressed-air transmissions. But that involves an oversight. The increased loss at the compressor, due to a higher working-pressure is partly balanced by an increased efficiency of the air motor, so that low-working pressures are not necessarily most economical for the whole system.

Case of Isothermal Compression.—The most economical compressor, mechanically, would be one in which the air was compressed isothermally, heat being abstracted during the compression, so that the temperature did not rise. In that case, the heat abstracted is exactly equal to the work done during compression.

The whole work, in a complete double stroke, consists of three parts—(1) The work, O A D E, of the atmosphere on the piston during the suction stroke; (2) the absolute work of compression, E D F H; (3) the work of expulsion of the air into the mains, O B F H. In isothermal compression, P V = constant. The effective work expended in driving the compressor, given by the shaded area A B F D,

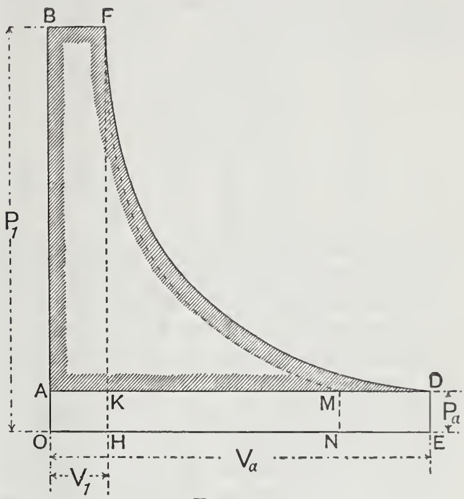

FIG. 24.

is the algebraic sum of the three quantities of work just stated. That is

$$-P_a V_a + P_a V_a \log_e \frac{P_1}{P_a} + P_1 V_1$$

$$= P_a V_a \log_e \frac{P_1}{P_a}$$

or exactly equal to the absolute work of compression, H F D E. But the heat abstracted during compression is also exactly equal to the area H F D E. Hence the curious result is arrived at that, in the most economical compression, the effective work of compression is entirely abstracted as heat, and wasted. All that the compression has done has been to put the air in a condition to do work in a motor at the expense of its intrinsic energy. The work in the motor is in no sense a return of the work expended in the compressor. Hence the conditions of transmission of power by compressed air are entirely different from those of transmission by pressure-water.

If the air is compressed isothermally, as it very nearly is in modern compound com-

pressors, then the question arises, how much work is obtained in the compressed-air motor? If the air is used non-expansively, as in the smaller motors used in Paris, and in much-compressed air plant, used for rock-drilling and similar purposes, the work done in the motor is simply the admission work, $P_1 V_1$, less the work of expulsion, $P_a V_1$, neglecting valve resistance and friction; that is, the work obtained is—

$$P_a V_a \left(1 - \frac{P_a}{P_1}\right)$$

The efficiency of combined motor and compressor is then—

$$\eta = \frac{1 - \frac{P_a}{P_1}}{\log_e \frac{P_1}{P_a}}$$

$P_1 =$ 2 3 4 6 8 10 atmospheres
$\eta =$ 0·72 0·61 0·54 0·46 0·42 0·39.

The efficiency diminishes rapidly with increase of initial pressure; and it is the use of bad and inefficient air plants of this kind which has given compressed air a bad name, and made engineers hesitate to adopt high working pressures. To obtain good results, the air must be used expansively. Suppose the air expands in the motor without gain or loss of heat, a realisable condition, and let clearance and loss in mains be neglected, as well as friction, then the indicator diagram of the motor will be A B F M, the expansion curve being an adiabatic F M, and the air cooling during expansion. The efficiency of the whole arrangement will be the ratio of the area A B F M to the area A B F D. It is easy to show that that efficiency is given by the equation

$$\eta = \frac{95600 \left[1 - \left(\frac{P_a}{P_1}\right)^{0·29}\right]}{27710 \log_e \frac{P_1}{P_a}}$$

Resultant Efficiency of Compressor and Motor.

Working-pressure lbs. per square inch. By Gauge.	Working-pressure lbs. per square inch. Absolute P_1	$\frac{P_1}{P_a}$	η
14·7	29·4	2	·906
44·1	58·8	4	·824
73·5	88·2	6	·780
102·9	117·6	8	·752

Practically, it is necessary to use pressures of 45 lbs. per square inch at least, that the apparatus may not be too cumbrous. The calculation shows that when using the air properly, much higher working pressures may be adopted without sensible loss of efficiency.

Various means have been adopted to cool the air during compression. Sommeiller adopted water pistons, which are very effective, and, in the early compressors at Mont Cenis, very good results were obtained. But there are practical objections to water piston compressors: they must be worked slowly, and are costly and cumbrous. In the St. Gothard compressors, the much less effective arrangement of a cold-water jacket was adopted; but air does not part with heat readily to a metal cylinder, and the cooling surface of the cylinder is too small to permit much of the heat to be abstracted, hence, later, a method proposed by Professor Colladon of injecting a water spray into the cylinder was adopted, and by this means a much more considerable cooling action was obtained. To some extent, however, the cooling action of the spray is deceptive: the cooling takes place partly in the passages of discharge, and the compression curve is not lowered so much as it should be.

Compound Compressors.—The author is not aware when compound compressors were first used. They were, it is believed, used by Mekarski, and, possibly, by others, in cases where a high pressure was required, at a comparatively early date. Mr. Northcott made a two-stage compressor, with intermediate cooling arrangements, in 1878. The Norwalk Company, in America, constructed compound compressors for mines in 1880, apparently more with a view to equalise the effort during the stroke, than to obtain higher efficiency. In 1881, however, they introduced an intercooler between the high and low-pressure compression cylinders. This consisted of a reservoir with thin brass pipes, through which cold water circulated. The effect of this intermediate cooling is very important in reducing the heating loss. The compound diagram is shown in Fig. 25. Air is compressed to P_1 in the low-pressure cylinder. Then, in passing through the intercooler, it shrinks in volume from H E to H D. It is then further compressed to P_2 in the high-pressure cylinder. The work saved by the intermediate cooling is the area E D C G. The adoption of these compound compressors is important, because it removes the chief objection to the use of high-

working pressures in a system of compressed-air transmission.

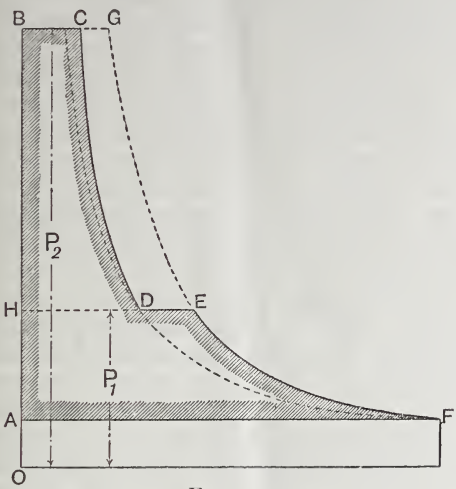

FIG. 25.

Compressor Valves.—In most compressors simple fluid moved valves are employed. The objection to them is that they create some prejudicial resistance involving waste of work, and they prevent the compressor being worked at high speed. In many compressors mechanically moved valves are employed, for instance, slide or Corliss valves. The compressor can then be run faster, but the resistance at the valves is still serious. Prof. Riedler uses valves which open automatically and are closed mechanically, and these no doubt obviate the objections to ordinary valves. Fig. 26 shows

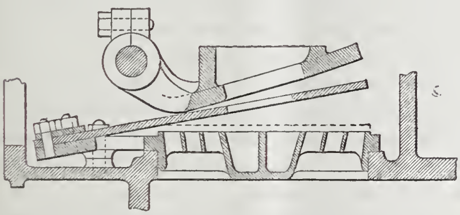

FIG. 26.

one form. This is a flap valve so set that it tends to open. It is closed by a lever worked by a cam.

Mr. Pearsall's Hydraulic Air-compressing Engine.—Mr. H. D. Pearsall, apparently incited by a study of the early hydraulic ram compressors of Sommeiller, has designed a very interesting hydraulic compressing engine, in which air is compressed directly by a water column, without cylinders and pistons.

Fig. 27 shows this engine in section. A is the supply pipe, by which water, with the energy due to its descent from a higher level, flows into the apparatus. C is a large cylinder valve which, when open, allows the water to flow out into the tail-race, and, when shut, forces the column of water to rise into the compression chamber, M. The column of water in the supply-pipe is allowed to acquire velocity by outflow into the tail-race. The valve, C, is then mechanically closed, and the descending column expends its energy in com-

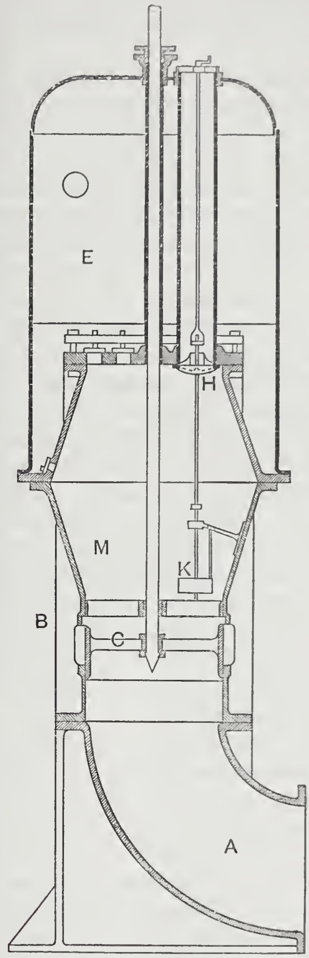

FIG. 27.

pressing the air in the chamber, M, and discharging it into the receiver, E. The cylinder valve, C, is actuated by a small air motor. The chamber, M, empties the water through the cylinder valve, C, and fills with air through the air valve, H, which is controlled by a float. The adjustment is such that the column of water can be made to come to rest at the instant when it reaches the delivery plate.

Mr. Pearsall claims that very high velocities

of flow can be permitted without danger or loss of efficiency. Some experiments made with a small apparatus gave an efficiency of 80 per cent.

The engine is simple, and there seems no reason why it should not have a high efficiency. But, till experiments have been made on a larger scale, it is impossible to say what the delivering capacity of the machine in a given time is. Till that is determined, it is uncertain whether it would be more costly or less costly than ordinary compressors worked by turbines.

Losses in Transmission.—The frictional resistances in a pipe conveying fluid are proportional to the density of the fluid; consequently, at equal velocities, the frictional resistance of air is enormously less than that of water. Conversely, air may be transmitted in air mains without serious fall of pressure, at 10 or 20 times the velocity practicable with water in water mains. Air, at 90 lbs. per square inch pressure, is about 115 times lighter than water, and the frictional resistance, at equal velocities, is less than one per cent. of that of water. In air mains there is nothing analogous to the hydraulic shock, due to changes of velocity, which, as well as the friction, leads to a limitation of the velocity of water in mains to 3 feet per second, in most cases, or to 6 feet per second in some cases.

In air mains, velocities of 30 to 50 feet per second are allowed, without serious frictional loss. In consequence of this high velocity, large amounts of power can be transmitted by air at moderate pressures, and in mains of moderate dimensions.

The hydraulic mains of the London Hydraulic Power Company are 6 inches in diameter, the pressure is 750 lbs. per square inch, and the velocity 3 feet per second. That corresponds to the transmission of 90 effective horse-power by each main. But air at 45 lbs. pressure per square inch, with a velocity of 50 feet per second, would transmit 150 effective horse-power in a main of the same size. The largest high-pressure hydraulic mains are 7 inches in diameter. But there is hardly any limit to the size of air mains. The new Paris main from the Quai de la Gare to the Place de la Concorde —7 kilometres in length—with air at 90 lbs. pressure per square inch, transmits 6,000 horse-power.

In the older Paris mains which were carried through the sewers, and which had an exceptionally large number of bends, draining boxes and other sources of resistance, the frictional resistance, with a velocity of 25 to 30 feet per second, only amounted to 2 lbs. per square inch, per mile of main. It would be only in very long distance transmissions that the fall of pressure in the mains would be large enough to sensibly affect the efficiency of the system.

As to the precise way in which a fall of pressure in the mains influences the efficiency, there is a word to be said. If air enters an air main at 60 lbs. per square inch gauge pressure, and reaches the other end at 55 lbs. gauge pressure, there being a fall of pressure of 5 lbs. due to friction, then it is commonly stated that $\frac{5}{60}$ths of the energy of the air is wasted. But this is altogether erroneous, the statement being based on a false hydraulic analogy. With the fall of pressure in the case of air, there is an expansion of volume which largely compensates for the loss of pressure. The intrinsic energy of the air from which the work of the air motor is borrowed remains constant. It is only because the air motor works against the pressure of the atmosphere that the available energy of air at 55 lbs. is less than that of air at 60 lbs. pressure.

Suppose that a given amount of work can be done by an air motor using a ton of air at 60 lbs. gauge pressure, or 75 lbs. absolute. The work expended in driving this motor by a compressor adjacent to it would be the work of compressing one ton of air to 75 lbs. absolute pressure. Now let the compressor be removed to a couple of miles distance, and the air supplied to the motor through a main, in which there is a fall of pressure of five lbs. per square inch. To do the same work as before, all that is necessary is that a ton of air should be compressed to 80 lbs. absolute pressure. The difference between the work of compressing a ton of air to 80 and to 75 lbs. absolute pressure is the loss of work arising out of the friction of the main, and this amounts, with fairly good compressors, to about 3 per cent.

In short distance transmissions the loss of pressure in the mains is so insignificant that it may be neglected. In long distance transmissions an accurate estimate of the frictional loss is necessary. The author believes that he has shown, using data derived from careful experiments on 20 miles of main in Paris, that long distance transmission of power by compressed air is perfectly practicable. It is possible, with compressors driven by engines working to 10,000 indicated horse-power, to transmit the air, in a main of not unusual size, a distance of 20 miles, and to obtain in motors worked by the transmitted compressed air from

4,000 to 5,000 indicated horse-power, if the air is used cold, or 6,000 to 7,000 indicated horse-power, if the air is re-heated before use.

The Air Motors.—The air motor is essentially a reversed compressor, but it is free from the heating difficulty. The air cools in expanding, and, in some cases, this causes trouble from the production of ice in the valve passages. The rounding of the edges of the ports so that the ice can be pushed away diminishes the trouble, and heating the air before use entirely obviates it.

Some special rotary motors of small size are used in Paris; but they are not economical, and most of the motors are simply non-condensing steam-engines adapted to use air. Probably the greatest cause of loss in air motors has been leakage, especially piston leakage. In a steam-engine, the condensation on the cylinder wall helps to make the piston tight. In an air motor the cylinder surface is dry, except so far as lubricant is supplied.

Cost of Working with Compressed Air.—Air motors can be obtained, erected complete, for two-thirds of the cost of a steam-engine and boiler. In the very imperfect small rotary motors in Paris, the consumption of air compressed to five atmospheres (75 lbs. per square inch.) is 750 to 850 cubic feet per effective horse-power hour. Old steam-engines converted to air motors use 450 cubic feet per effective horse-power hour. Now, the new compound air compressors at Paris compress a cubic metre of air to a higher pressure than this for 0·4 centime. If 0·75 centime per cubic metre is allowed to cover interest on plant, as well as cost of compression, this corresponds to 1d. per 880 cubic feet of compressed air. Hence, the cost of working with compressed air amounts to 1d. per effective horse-power hour with the inefficient rotary motors, and about ½d. per effective horse-power hour with the converted steam-engines. In the latter case the cost corresponds to about £6 5s. per effective horse-power for a year of 3,000 working hours. Better results than these will be obtained when air motors are studied as carefully as air compressors.

Heating Air before Use in Motors.—The amount of expansion which can be permitted in air motors, without inconvenience from the fall of temperature, is limited. Any difficulty thus arising is obviated if the air is heated immediately before it is used.

Quite apart, however, from the removal of a practical difficulty, the reheating of the air before use is of the greatest economical importance. The air when heated expands, and more work is obtained in the motor per pound of air used. Whether it is economical or the reverse to heat the air before use depends on this—whether the additional work obtained is more or less valuable than the coal expended. Experience shows that it is extremely advantageous economically to reheat the air. The heat supplied is used with great efficiency, and a larger fraction of it is converted into work than in ordinary heat-engines. Further, very small, easily managed, and simple reheating apparatus can be employed. A simple coil of pipes, with a small furnace capable of heating the air current to 300° F., may increase the work done per pound of air by 25 or 30 per cent. The heat, according to the experiments of Riedler and Gutermuth, is used five or six times as efficiently as heat supplied to a good steam-engine.

Fig. 28 (p. 958) shows a simple form of reheating oven. The compressed air passes through a double spiral pipe, C. The furnace gases rise through the centre of the coil and descend on the outside in a cast-iron casing, with a spiral diaphragm or rib. The grate is at F. The air discharged from the motor M may be used to create a chimney draught. This has the advantage that the draught varies with the amount of work done. As air does not readily take up heat from metal surfaces, it is advantageous to introduce a small quantity of water into the spiral pipe of the re-heater. The water is evaporated into steam, and in the motor the steam condenses, giving back the latent heat to the expanding air. The water may be supplied from a reservoir above the oven, to which the air pressure is admitted, so that the water descends into the heater by gravity. The reservoir can be re-filled by shutting off the air pressure. Steam thus used is extremely efficient in increasing the work done by the air; and probably the moisture in the cylinder helps to prevent wear and leakage.

In some simple re-heaters, tested by Prof. Gutermuth, in Paris, the air was heated from temperatures of 45° to 122° up to temperatures of 224° to 363°. From 8,035 to 10,070 thermal units were given to the air per pound of coal used. About 5,200 thermal units were transmitted to the air per hour per square foot of heating surface.

Combination of a Gas-motor and Air-engine.—In a scheme for distributing power, chiefly by compressed air, for the town of Dresden, Dr. Prœll proposed to work an elec-

tric-lighting station partly by air-motors, and partly by gas-engines. The ordinary reheating apparatus for air-motors is not very convenient in this case, in consequence of the great variation in the demand for power. Hence Dr. Prœll adopted the plan of combining gas-engines with air-motors. The gas-engine is, itself, a very efficient and convenient motor

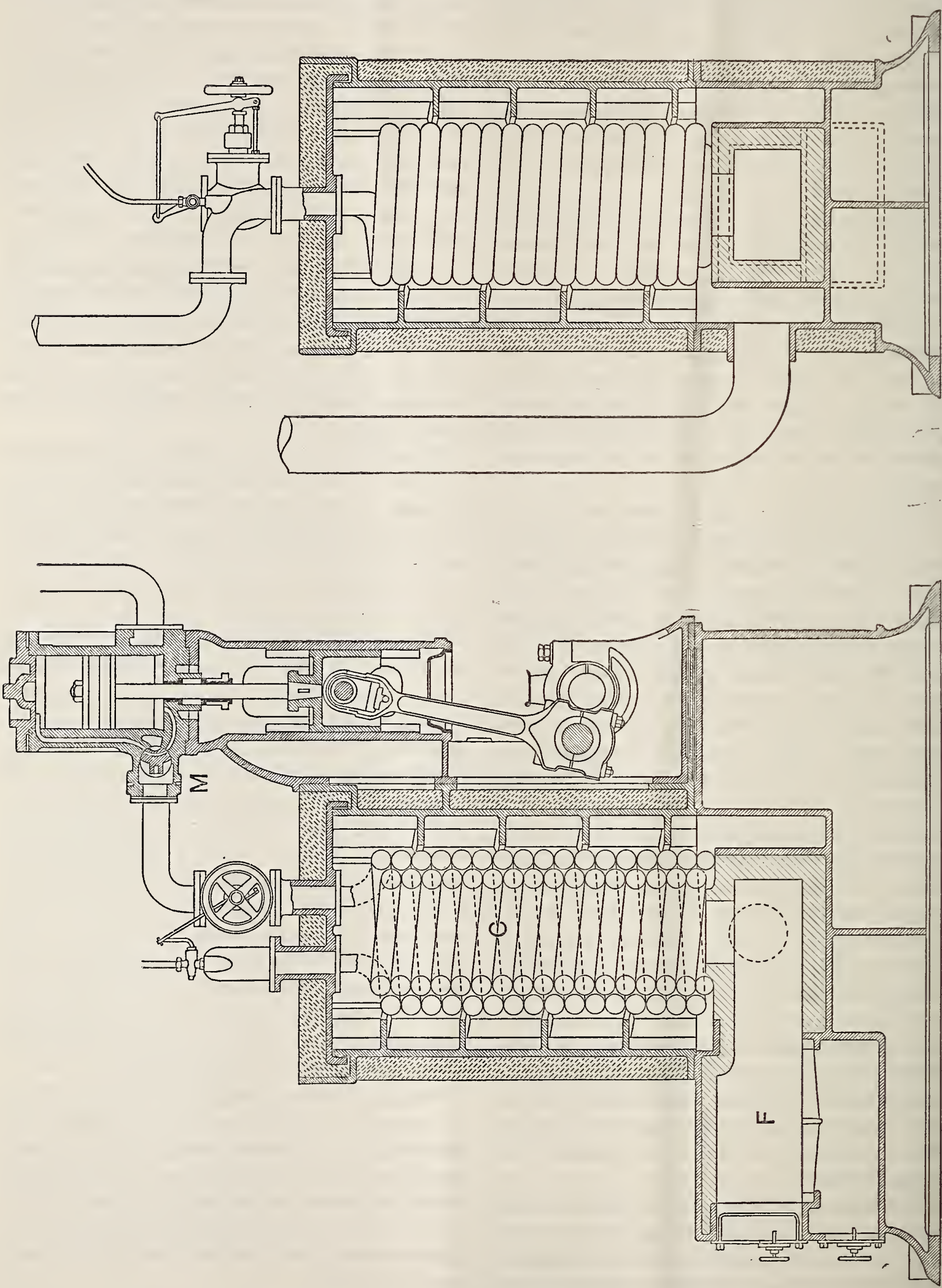

FIG. 28.

for an electric-lighting station, because it can be put in action or stopped, according to the variation in the demand for power, and there is no waste like that due to keeping boilers in steam ready for use. But in gas-engines a very large fraction of the heat developed is necessarily wasted in the water-jacket. Dr. Prœll proposed to abolish the water-jacket, and

to take the compressed air through the gas-engine jackets, to re-heat it on its way to the air-motors. In addition, the hot gases rejected from the gas-engine were to be used in the jacket of the air-motors. Undoubtedly by the combination of the gas-engine and the air-motor, a quite remarkable thermal efficiency could be obtained.

It may be questioned whether it would not be better to take the exhaust of the gas-engine directly into the air current. Then the gas-engine would work with a heavy back pressure, but the work so lost would be recovered in the air motor. In a paper on compressed air,* the author suggested reheating by the burning of gas in the air current, so that the whole of the heat would be utilised without chimney losses. Some attempts have since been made in this direction in America. Fig. 29 shows a

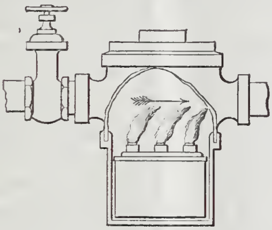

Fig. 29.

small petroleum burner used in the air main supplying compressed air to rock-drilling machinery.

Meters for Measuring Air Supplied to Consumers.—Various types of meters have been used in compressed-air systems. Very accurate displacement or positive meters can be constructed, but they are costly; hence, inferential meters, which are virtually air-turbines driven by the air current, are more commonly used. Fig. 30 shows an arrangement, designed by Mr. Abrahams, of the Birmingham Compressed Air Company, which is stated to have worked with an accuracy within one per cent. With a simple fan or turbine, driven by the air current, the velocity of the meter is not proportional to that of the air current, in consequence of the friction of the meter. If set to be right, at a mean velocity, it over registers with a fast current, and under-registers with a slow current. Mr. Abrahams added a kind of pendulum governor, the balls being replaced by hemispherical cups. The governor creates a resistance increasing with the radius of the circle in which the cups revolve, and therefore with the speed of the meter. This extra resistance may be made to balance the tendency to over-register.

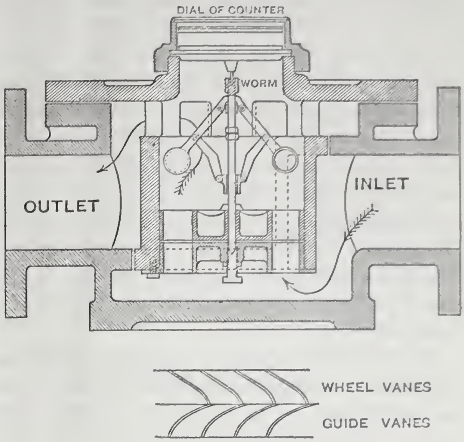

Fig. 30.

Distribution of Power by Compressed Air at the Works of the Société Cockerill at Seraing.—The great works at Seraing may be considered the birthplace of modern compressed-air machinery. The compressed-air plant for the Mont Cenis Tunnel works was made at the Cockerill works, having been designed and constructed under the direction of Mr. J. Kraft, who is now at the head of the engineering staff of the works. In conjunction with M. Sommeiller, Mr. Kraft carried out extensive experiments on the efficiency of air-compressing machines in order to obtain the necessary data as a guide in attacking what was then a new problem. Compressed air in mines was first used and is still extensively used at the Marihaye collieries at Seraing. Further, since 1854, compressed air has been used in the engine works of the Société Cockerill for working cranes.* With regard to this last application, Mr. Kraft states that "it might be expected that the losses of power incurred in the production and the utilisation of compressed air would cause it to be rejected as a motive power. But in many cases it is not so; for instance, for a series of cranes, machines working only at intervals, where steam is used, enormous losses are caused by condensation in the pipes; and expansion and condensation can hardly be used in the engines; whereas, on the other hand, compressed air can be produced by high-class engines consuming very little coal. In this

* "Transmission of Power by Compressed Air." "Proc. Inst Civil Engineers," vol. xciii.

* "Notes on Compressed Air and Machinery for Utilising it." By John Kraft. "Proc. Inst Civil Engineers," vol. 89.

way, the loss incurred by employing air may be compensated for. For a set of cranes like those at the Cockerill Works, or at Portsmouth Dockyard, steam cannot compete with air. The principal rival of compressed air is water, and there are many cases where water is to be preferred. For cranes placed in the open air in cold countries, the great impediment to the use of water is frost. For the installation of a number of cranes in the open air, along a quay wall, Mr. Kraft thinks that air is preferable, as in the case of Portsmouth Dockyard." The compressed-air machinery erected in the engine works at Seraing in 1885 —and still in use—consisted of the following machines:—

A. Air-compressing engine, with two cylinders. Diameter of steam cylinders and air cylinders, 13·78 inches; stroke, 29·53 inches; revolutions per minute, 26.

B. Air reservoirs (two). Length, 36 feet; diameter, 6½ feet; maximum pressure, 5 atmospheres; diameter of pipes, 2 inches.

C. 40-ton travelling crane, with two double cylinder air motors. Diameter of cylinders, 4·53 inches; stroke, 7·09 inches. The air is supplied to the traveller by a flexible pipe, which coils on to or off a drum, as the traveller approaches to or recedes from one end of the building. The crane has worked very satisfactorily, and was at work this year (1893).

D. Three 4-ton swivel cranes.

E. Air motor working hydraulic pumps for wheel press.

F. Twelve 12-ton swivel cranes.

G. Two 15-ton swivel cranes.

The compressing engine stops automatically, when the pressure reaches 75 lbs. per square inch, and begins working again when the pressure falls. The air cranes differ in no respect from steam cranes, so far as their engines are concerned; and all can be worked with a pressure of 45 lbs. per square inch. Also an overhead traveller, with a reservoir of air at 90 lbs. has been erected in the foundry. The air is supplied to the engine through a reducing valve, at 40 lbs. per square inch.

Compressed Air in Mines.—One of the largest mining plants worked by compressed air is that at the Chapin Mine, Michigan.*

About three miles from Iron Mountain at Quinesec Falls, on a head of 52 feet, 1,700 horse-power is obtained by four turbines. Each of these drives two Rand compressors. About 2½ million cubic feet of air are supplied per day at 60 lbs. per square inch gauge pressure. From the compressor plant, a 24-inch wrought-iron main, ¼ inch thick, extends for three miles, an expansion joint being used at every 480 feet. The air main is connected to the machinery, and to 105 power drills at the Chapin mine, and also to some neighbouring mines. Most of the machinery is arranged so that by closing one valve and opening another a change can be effected from working by air to working by steam.

* See the "Iron and Steel Institute in America," p. 378.

System of Transmitting Motive Power by Vacuum.—An interesting plant for distributing motive power by vacuum was established in the Rue Beaubourg in Paris by MM. Petit and Boudenoot.* The general object in view was the distribution of power to small industries. From 1874, M. Petit had the idea of transmitting power by vacuum. In 1882, an association was formed, and machinery erected. Conduits were laid communicating with the houses of consumers, who paid a rental based on the number of rotations of their machines, ascertained by a counter. The users of power were interested in the success of the scheme by participation in the profits. The working hours are from 7 a.m. till noon, and from 1 p.m. till 8 p.m. A steam-engine and exhausting pump of 70 to 80 horse-power was first erected, the mains extending 300 to 400 yards. Now there are three steam-engines, developing, altogether, 300 horse-power, and the mains extend 850 yards. There are about 150 small motors on the mains. Part of the power is rented to an electrical company. This power is supplied by a fourth engine of 100 horse-power. M. Boudenoot gives the preference to a vacuum system, because the cost of machinery is less than for a compressed-air system. The mains are always dry, and do not require draining boxes. Lastly, the efficiency of a vacuum system is greater. M. Boudenoot takes the efficiency of the exhausting pump at 0·93; the mechanical efficiency of the vacuum motor at 0·60; and the efficiency of the expanding air in the motor at 0·85. The resultant efficiency is then

$$0{\cdot}93 \times 0{\cdot}60 \times 0{\cdot}85 \times 0{\cdot}95 = 0{\cdot}45.$$

This, for small motors, is a good result. The exhausting cylinders make 20 to 50 revolutions per minute, and maintain a vacuum of 0·67 to 0·80 atmosphere. These cylinders have spray

* "Transmission de la force motrice par l'air raréfié," par M. Max Nansouty. Genie Civil, 1886. "Distribution de la force motrice à domicile au moyen de l'air raréfié," par M Boudenoot, Mem. de la Société des Ingenieurs Civils, 1885 and 1889.

injection. The motors are constructed to supply 360, 540, and 900 foot-pounds per second. There is a vacuum reservoir 50 inches in diameter and 140 inches in height attached to each motor. The vacuum mains are 10, 8, 6, and 4 inches in diameter. The house service pipes are of lead.

The Paris System of Distribution of Power by Compressed Air.—The Paris power distribution is at present the largest in Europe, but it developed out of very small beginnings. About 1870, MM. Popp and Resch established, first in Vienna and then in Paris, a system for regulating clocks by impulses of compressed air. At first in Paris there was a central station in the Rue Argenteuil with two small compressors delivering air into a receiver at two to three atmospheres presure. In a second receiver, air was maintained at a constant pressure of $1\frac{3}{4}$ atmospheres. Two clocks (one in reserve) actuated a distribution valve, allowing air to pass into the mains for 20 seconds in each minute. By means of small pipes laid chiefly in the sewers the air impulses were conveyed to the clocks which were to be regulated. At the clock a small bellows lifted a rod at each impulse and moved the escapement of the clock. The air mains were generally $\frac{5}{8}$ to $\frac{7}{8}$ inch in diameter, and the service pipes into the houses $\frac{1}{4}$ to $\frac{3}{8}$ inch in diameter. These pipes were extended over many miles, and in 1889 there were in Paris 8,000 clocks regulated by the pneumatic arrangements.

The system proved so successful that a new central station was erected in Rue St. Fargeau, in Belleville. Down to 1887, two small Farcot engines and a beam engine sufficed for the work.

Gradually, there arose a demand to use the compressed air for small motors. An extension of the station was then made, and a second installation erected in the Rue St. Fargeau. This consisted of six Davey-Paxman compound engines, each driving two compressing cylinders. The engines developed 2,000 horse-power. The compressors were made in Switzerland, on the Blanchard system. Soon this plant became insufficient. A third installation was erected in the Rue St. Fargeau, in 1889. This consisted of five compound engines and compressors, built by the Société Cockerill, at Seraing, the compressors being on the Dubois-François system. These engines developed 2,000 horse-power. Finally, another central station, at the Quai de la Gare, was erected, with engines of 8,000 horse-power, and room for extension to 24,000 horse-power. The engines are triple vertical engines. with Riedler compound compressors. The air is compressed so much more cheaply at the new station that the old station in the Rue St. Fargeau is no longer worked.*

At the St. Fargeau station neither the engines nor the compressors were of the best type. Their effect was to compress 265 cubic feet of air at atmospheric pressure to six atmospheres, per indicated horse-power hour. The cooling in the compressor cylinders was ineffective. The air from the six compressors was delivered into eight cylindrical receivers of 1,150 cubic feet capacity each. The air was then distributed by cast-iron mains, 11·8 inches in diameter. These had joints with indiarubber rings forming a kind of stuffing-box, and permitting expansion at every pipe length without leakage. The mains are laid partly under roadways, and partly in sewer subways. They are supplied at intervals with automatic draining boxes. It was remarkable that the demand for power from this station so rapidly grew up to its full capacity.

The air motors used were generally of a simple kind. For small powers a simple rotary engine was used. For larger powers steam-engines were employed, worked with air instead of steam. Where the compressed air enters a building it generally passes through a screen which removes solid impurities. Then there is a stop-valve and a meterfor measuring the air. Next there is often a reducing valve by which the pressure is reduced to $4\frac{1}{2}$ atmospheres. In most cases there is a re-heater, often a simple double-walled box of cast-iron, in which the air circulates, and is heated by a coke fire. For a 10 horse-power motor this re-heater is about 21 inches in diameter and 33 inches high. The amount of coke used is not considerable, about $\frac{1}{4}$ lb. per horse-power hour. The air is raised in temperature to 300° Fahr. The air motors are very convenient. They can be started at any moment, they are free from inconvenience from leakage, heat, or smell, and they require a minimum of attendance. Often the exhaust can be used to cool and ventilate the working rooms. The air motors are used for various purposes. At some of the theatres and restaurants they drive dynamos for electric lighting. At some of the newspaper offices there

* For numerous details and data relating to the Paris system, see "Neue Erfahrung ueber die Kraft versorgung von Paris durch druckluft." Von A. Riedler, Berlin, 1891. "La Distribution de la force par l'air comprimé dans Paris," par Prof. Riedler. Paris, 1891.

are motors of 50 and 100 horse-power, driving printing machines. In workshops there are motors driving lathes, saws, polishing, grinding, sewing, and other machines. At the Bourse de Commerce, the compressed air drives dynamos for electric lighting, and also is used to produce cold in large refrigerating stores. In many of the restaurants air is used for cooling purposes. It is also used to work cranes and lifts directly, a water cushion being used between the working cylinder and the lift.

In the first compressors at the Rue St. Fargeau, about 265 cubic feet of air was compressed to six atmospheres per indicated horse-power hour. The second installation had somewhat better compressors. These compressed about 300 cubic feet of air per indicated horse-power hour.

Later, permission was given to Prof. Riedler to convert one of the Cockerill compressors into a compound compressor. After the change, 370 cubic feet of air were compressed to 6 atmospheres per indicated horse-power hour. In the large new compressors at the Quai de la Gare 438 cubic feet of air are compressed per indicated horse-power hour. The general result of the working of the new station is that a cubic metre of air is compressed to seven atmospheres for 0·4 centimes, or about $\frac{4}{10}$ths of the cost of compression at the older station.

In the new station the steam-engines are vertical triple engines, working compound compressors with two low and one high pressure compressing cylinders. Each engine is of 2,000 horse-power. Four have been erected, three being regularly worked and one kept in reserve. The new station has been placed on the banks of the Seine, where coal and condensing water can be obtained cheaply. Steam of 180 lbs. per square inch pressure is used, and the makers guaranteed that the engines would work with 1·54 lbs. of coal per indicated horse-power hour. The new air main, about seven kilometres in length, is 20 inches in diameter.

Compressed Air System at Offenbach, near Frankfort-on-Maine.—A compressed-air distribution of the most improved type has been constructed at Offenbach, by the firm of Riedinger, of Augsburg. The compressing station has a horizontal compound steam-engine, with crankshaft and fly-wheel. The air compressors are compound, of Riedler's design. The air is compressed to two atmospheres in the first cylinder, and then to six atmospheres in the second. The heat is abstracted in an inter-cooler between the high and low pressure cylinders. The steam cylinders are 22 and 31 inches diameter and 40 inches stroke. Each air cylinder is worked direct from the back of the corresponding steam cylinder. The engine is stated to work with $15\frac{1}{2}$ lbs. of steam per indicated horse-power hour, and the efficiency of the compressor is 87 per cent. The engine runs at 75 revolutions, or 490 feet of piston speed per minute. The air is distributed through 23,000 feet of cast-iron mains, with india-rubber ring joints. The main, when tested with a pressure of $6\frac{3}{4}$ atmospheres kept up for 70 hours, showed a leakage of only 1·6 cubic feet per mile per hour.

Distribution of Power by Steam.

Most commonly where steam-power is used, the boilers which generate the steam are near the engines which generate the power. But in special cases it has been necessary to convey the steam some distance before it is used in engines. Sometimes pumping machinery underground has been worked from steam boilers above ground by steam conveyed in pipes, protected as far as possible from heat losses by radiation. It would, nevertheless, hardly have been thought very reasonable to distribute steam widely for power purposes through pipes, but for a secondary object. Steam distributed from a central station can be very conveniently used for heating purposes as well as for power purposes. The defects of steam as a means of distributing power may be balanced by its convenience as a means of distributing heat. At any rate, in America the experiment of distributing heat and power from a central station by steam has been tried on a very large scale, and with a considerable amount of success.

In 1877, Birdsill Holly took out a patent for a system of steam distribution for heating purposes only. The steam was carried in pipes, having anchored stuffing boxes at distances of 100 feet, so that the expansion and contraction of the mains was provided for. The pipes were protected against radiation by asbestos and wood. Steam was distributed to each building through a reducing valve, and used at low pressure in heating coils in the ordinary way. The condensed steam was discharged through steam traps into the sewers. Generally the condensed steam, before being discharged, was taken through coils in a chamber where the air entering the building

was warmed, and the condensed steam reduced in temperature to about 100°. Plants on this system were erected in many towns. In Lockport, for instance, in 1879, the main steam pipes extended a distance of 16,000 feet.

As early as 1869, Mr. Emery investigated the problem of distributing steam in New York,* and the result of his studies was the creation of the largest system of steam distribution hitherto erected. Mr. Emery concluded that steam could be economically distributed from one station to buildings within a radius of half a mile.

In New York ten plots for stations were secured, and work commenced in 1881. So far as the author knows there are now two steam stations in New York, a down-town station termed Station B in Greenwich-street, which has boilers working to about 16,000 horse-power, and an up-town station in Fifty-eighth-street, designed for boilers of 3,000 horse-power, and having about half this power at work.

The pipes from the down-town station extend through about $5\frac{1}{2}$ miles of streets; those from the up-town station through $2\frac{1}{4}$ miles of streets. They work with steam at 80 lbs. to 90 lbs. pressure per square inch. The main pipes are of wrought iron, 16, 15, 13, and 11 inches in diameter outside, and about $\frac{1}{2}$ inch less in diameter inside. Return mains were also laid for the condensed water. These were 6 inches and 8 inches in diameter near the stations, decreasing to 4 inches, and even to $2\frac{1}{2}$ inches, towards the ends of the pipe lines. More recently the return mains have been disused on account of their rapid corrosion.

The steam is used for a great variety of purposes, in addition to the principal purpose of warming buildings. It is used for driving engines for various manufacturing purposes; for driving engines for electric lighting; for engines working lifts, and for engines for ventilation. In 1887, there were some 500 engines worked with steam from station B.

Prevention of Loss by Heat Radiation.—To prevent loss by radiation, the pipe is surrounded by non-conducting material. For this purpose, in different cases very different materials have been used. Straw, laid parallel to the pipes, and covered with loam, is effective; but there have been used felt, cork, fossil meal, *papier maché*, slag wool, and asbestos. Slag wool, obtained by blowing superheated steam through molten slag, is exceedingly efficacious, from the large amount of air it retains in the interstices of the wool; but, if it gets moist, the sulphur it contains causes rapid corrosion of the iron pipes. Probably, with any of the coverings mentioned, moisture would also be very injurious.* It is, therefore, important to keep the outside of covered pipes dry, and this is best secured when the pipes are kept continuously heated.

In the case of the New York steam supply, the pipes are laid in brick trenches, the brickwork being kept 4 inches away from the pipes. The pipes were coated with hot asphalt varnish and the space packed with slag wool. Over the pipes a roof of short planks smeared with tar and bedded in cement is used, and a covering of tarred paper over the planks was carried well down the side walls to exclude percolating moisture.

The general arrangement of the pipes is to have an expansion joint every 50 feet, and two intermediate joints, all the joints being carried on brick piers with a stone cap. At all dips in the pipe traps are connected for discharging the condensed steam.

Quantity of Power transmitted by Steam Mains.—If it is assumed that the velocity in the mains is u, and v is the specific volume of the steam. Then the weight in lbs. of steam transmitted per second, in a pipe of section Ω square feet, is

$$W = \frac{u}{v}\,\Omega,$$

if we take $u = 80$ feet per second,

$$W = c\,\Omega$$

where c is a constant for any pressure.

Gauge pressure.	Absolute pressure.	v Cubic feet. per lb.	c
lbs. per sq. in.	lbs. per sq. in.		
45	60	7·04	11·36
75	90	4·81	16·63
125	140	3 18	25·15

Suppose that, in accordance with Mr. Emery's estimate, 30 lbs. of steam per hour is taken to furnish an I.H.P. in ordinary engines. Then the horse-power transmitted will be 120 W.

* Emery on "District Distribution of Steam in the United States." "Proc. Inst Civil Engineers," vol. xcvii.

* "Proc. Am. Soc. C. E.," xii. p. 263.

Diameter of Main in inches.	Steam gauge pressure.	Weight of steam conveyed.	H.P. transmitted by main.
	lbs. per sq. in.	lbs. per sec.	
6	45	2·23	267
,,	75	3·26	391
,,	125	4·93	592
12	45	8·92	1,070
,,	75	13·05	1,570
,,	125	19·74	2,370
18	45	20·07	2,410
,,	75	29·38	3,530
,,	125	44·45	5,330

These figures are, necessarily, rough values. But they show that, with steam, very large amounts of power can be transmitted, without sensible pressure loss, through mains of moderate size.

Miscellaneous.

*GEOLOGY IN SECONDARY EDUCATION.**

By Prof. Grenville A. J. Cole, F.G.S.

This paper is intended to be introductory to a discussion of the methods of teaching geology, with a view to making the general results of research in that science more accessible as a branch of education.

The need for selection of subjects in modern education is fully admitted; but it is urged that, following on the study of elementary chemistry and physics, geology forms a subject of such far-reaching importance that it should be included in the general curriculum for boys and girls about the age of sixteen or seventeen.

The utility, in a technical sense, of such knowledge is not here insisted on. But everyone upon this earth should be capable of appreciating his surroundings, and particularly the past history of life upon the globe, if he is to be able to pass judgment upon current affairs, and to play his part as an individual organism.

It is urged that geology is as fundamentally important as history, and tends to modify very largely our conceptions of the relations between what is called "antiquity" and ourselves. Besides this, in common with other natural sciences, it encourages a love of truth where statements can be safely made, and of reserve where assertions would be merely dogmatic.

The course suggested for all pupils is one in which mineral details are subordinated, except where they are important in explaining the origin of certain broad features, such as familiar and local landscapes. It is proposed to avoid the use of microscopic sections, and rather to rely upon powdered specimens for the determination of the constituents of such simple rocks as are dealt with. The greatest stress for general purposes is to be laid upon an outline of stratigraphical geology, and its illustration by such beds, unconformities, &c., as may be exhibited in the environs of the school. The out-door character of the study should be insisted on; and the fact that the broader generalisations of the science are based on the collation of local observations will not be among the least valuable results of the introduction of the subject into our educational systems.

* Paper read at Nottingham before Section C of the British Association, September, 1893.

General Notes.

Lord Alfred Churchill.—In the obituary notice of the late Lord Alfred Churchill, in last week's *Journal*, it should have been mentioned that his lordship served in the 4th Hussars as well as in the 83rd Foot. The funeral took place on September 27th in the churchyard of Stanford Church, Worcestershire, at Stanford Court, the seat of Lord Alfred's son-in-law, Sir Francis Winington, Bart. The mourners were his four daughters, Sir Francis Winington, and his grandsons.

Technological Schools in Australia.—The number of pupils on the rolls of Schools of Mines and Schools of Art, under the direction of the Education Department in Victoria, during the year 1891 was 8,500, and the aid afforded by the Government, £33,601 9s. 2d. The pupils included 2,096 artisans, 968 apprentices, and 2,241 girls. The number of teachers was 196. The total outlay on public instruction in this colony in 1852 was £13,495; in 1891 it amounted to £726,711.

Tasmanian Exhibition, 1894-95.—An International Exhibition, under the official patronage of the Government of Tasmania, will be held at Hobart during the summer of 1894-95. There will be a Fine Art Section, for which a special block of the building will be reserved; also a Women's Industrial Section and an Artisan Section. The site, which has been granted by the Government for the Exhibition buildings, covers about 11 acres, and is said to be one of great beauty and convenience.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Proceedings of the Society.

HOWARD LECTURES.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.

By Prof. W. Cawthorne Unwin, F.R.S.

Lecture VI.—Delivered February 17, 1893.

Distribution of Power by Gas and by Electricity.

Distribution of Gas for Power Purposes.—The distribution of gas for power purposes involves nothing new or untried. Coal gas is manufactured on an enormous scale, and distributed widely over extensive town districts. In the United Kingdom there has been expended on capital account in gas undertakings a sum of £60,000,000. The amount of coal carbonised annually is 10,000,000 tons, and the quantity of gas manufactured is 98,000 million cubic feet. If there were a demand for gas for heating and power purposes, there is no likelihood of failure of ability to supply and distribute it. Coal gas is already in many towns used on a considerable scale for heating and motive power. Mr. Trewby, the President of the Institute of Gas Engineers, estimates that, in the London district alone, there are 70,000 gas-cooking and heating stoves, and 2,500 gas-engines.

Gas distribution has one distinctive advantage over compressed air or electricity distribution, namely, that the manufacture is carried on continuously through the 24 hours, the fluctuations of demand being met by storage, which is neither difficult nor expensive.

There is no reason to think that the cost of ordinary lighting gas is so high as to preclude its use on a considerable scale for power purposes. Taking the cost of lighting gas at 2s. to 3s. per 1,000 cubic feet, and the consumption of a gas-engine, on an ordinarily varying load, at 26½ cubic feet per hour per horse-power, the cost of the power for gas, exclusive of interest on the gas-engine, comes to £8 to £12 per horse-power per year of 3,000 working hours.

But the cost at which lighting gas is sold includes interest on a vast network of mains and the loss due to leakage over an extensive area. This part of the cost is not fairly chargeable against gas used for power purposes. In an installation for power the system of mains would be far simpler than in a distribution for lighting. With a comparatively few consumers taking comparatively large quantities of gas at a steady rate throughout the year, all the interest and depreciation charges would be smaller than those incurred in a distribution of lighting gas to a multitude of comparatively small consumers. It appears that the cost of the manufacture of coal gas, including coal, wages, and petty stores, is about 10d. per 1,000 cubic feet. Probably 18d. per 1,000 cubic feet would allow sufficient margin for profit and cost of distribution to power consumers in a manufacturing quarter not unfavourably distant from the generating works. But at that cost per 1,000 cubic feet, the cost of the power would be only £6 per effective horse-power per annum. The charge for interest and depreciation on the motor plant and for wages would not add to this more than £3, making the total cost to the consumer £9 per effective horse-power per annum.

Central Electric Lighting Station at Dessau.—This station, where the motive power is produced from gas-engines worked with lighting gas, has been sufficiently successful to show that such a method of obtaining power is commercially possible. The motor installation consists of two two-cylinder (Otto system) gas-engines of 60 horse-power each; one single cylinder engine of 30 horse-power; and one of 8 horse-power. The group of engines work to about 160 effective horse-power. Directly coupled to these are dynamos of corresponding power. The 8 horse-power engine is used for day-work and for starting the larger engines. The jacket water is cooled by air-coolers, and used over again. There are 1,076 square feet of cooling surface. An injector, worked by pressure-water from the town mains, circulates air through the coolers. The water consumption is thus reduced to 5 gallons per horse-power hour for all purposes,

In an electric station, gas-engines have the advantage that they can be started and

stopped when required, and have no stand-by losses like those of steam-boilers. At Dessau, a large accumulator battery is used for storing energy when the engines supply in excess of the demand, and restoring it in hours of small demand. The efficiency of the battery on the average of the year is 79 per cent. About 52 per cent. of the whole supply passes through the battery, so that the waste of current due to the battery is about 11 per cent. of the total yearly supply.

The average gas consumption of the motors is 26½ cubic feet per effective horse-power hour. Motors of varying power were adopted with an idea that they would best meet a varying demand. The constructors of the station now think that the accumulator battery renders this unnecessary, and that motors of a larger and uniform size would be more economical. They claim, as advantages of a gas plant compared with a steam plant, that less space and less water is required; that there is absence of smoke and danger of explosion; and that gas stations can be distributed more easily over the area to be supplied.

Distribution of Natural Gas at Pittsburgh, U.S.A.—A remarkable case of distribution of gas for heating and power purposes has been in operation at Pittsburgh.* The natural gas has entirely taken the place of coal in manufactories and for domestic heating in a district where coal is exceedingly cheap. Coal could be obtained at Pittsburgh for 4s. to 5s. a ton, and coal slack at 2s. to 2s. 6d. a ton.

The natural gas was met with in boring for oil, and was first used to raise steam for the oil-pumping engines. At 18 miles from Pittsburgh, an enormous outburst of gas occurred, which, for five years, was allowed to burn to waste. Then a company engaged to take it a distance of nine miles to Messrs. Carnegie's works. They were to be paid for the gas the value of its equivalent in coal, until the capital cost of the pipes was repaid. After that, the gas was to be supplied at half the cost of its equivalent in coal. In 18 months the cost of the pipes was repaid, and the gas was then supplied at half the cost of its equivalent in coal. It was then conveyed into Pittsburgh, and still greater distances. When Mr. Carnegie described the operations, there were eleven gas mains, of six to twelve inches diameter, conveying gas to Pittsburgh.

The largest well discharged 30,000,000 cubic feet per day, and other wells half that quantity. At the wells the gas had a pressure of 200 lbs. per square inch; and at Messrs. Carnegie's works, nine miles distant, the pressure was 75 lbs. per square inch. This gave rise to difficulties from leakage, and it was found desirable to reduce the pressure in the pipes in towns, and even to place ventilating pipes at every joint in the mains, leading the leakage above the level of the street lamps. In using natural gas one fireman can manage boilers developing 1,500 horse-power.

* See a paper by Mr. Andrew Carnegie on "Natural Gas," read before the Iron and Steel Institute.

Density and Calorific Value of Gas.

	Cubic ft. per lb.	Calorific value Thermal Units.		Oxygen required for combustion per cubic ft in cubic ft.	Oxygen required for combustion per lb., in lbs.	Volume of products of combustion with air in cubic ft., per cubic ft.
		Per cubic ft.	Per lb.			
Manchester Gas	—	—	—	1·229	—	6·29
American Gas	26 5	616	16,326	1·320	—	—
London Gas	33·7	617	20,801	1·157	3·48	—
Petroleum	—	—	20,363	—	3·35	—
Pittsburgh Gas	24·75	833	20,610	1·48	3·27	7.50
London Gas	30·3	633	19,199	1·24	3·35	—
Dowson Gas	14·89	160	—	0·24	0·32	2·74
Water Gas (*a*)	26·0	284	7,373	—	—	—
,, ,, (*b*)	20 8	640	13,317	—	—	—

(*a*) Not carburetted. (*b*.) Carburetted.

Other Gas Supplies for Heating and Power.—A cheaper gas than lighting gas can be manufactured for heating and power purposes. (1.) So-called "water gas," obtained by injecting superheated steam through incandescent anthracite or gas coke. Such gas

has a volume of about 26 cubic feet to the pound, and develops about 7,373 thermal units F. per pound. (2.) Dowson gas, made by passing air and steam through incandescent coal or coke. This gas contains a large amount of nitrogen, with the hydrogen and oxide of carbon. Four volumes of it are about equal in calorific value to a volume of lighting gas. It developes 160 thermal units per cubic foot. With anthracite at 13s. a ton, Dowson gas costs about 2d. per 1,000 cubic feet, exclusive of interest and depreciation on plant. (3.) Mr. Thwaite has proposed for power purposes a gas of about 12 candle-power, obtained by mixing lighting gas and producer gas. Such gas can be manufactured for 4d. per 1,000 cubic feet, and could be distributed and sold profitably for 16d. per 1,000 cubic feet. Its calorific value is little lower than that of lighting gas.

The preceding Table (p. 966) contains data about various qualities of gas.

Formula for Flow of Gas in Pipes.—Let P_1 P_2 be the initial and terminal pressures in a main of length L (foot units). The velocity of flow is given by the equation*—

$$u_1 = \sqrt{\left\{\frac{g\,c\,T\,m}{\zeta\,L}\;\frac{P_1^2 - P_2^2}{P_1^2}\right\}}$$

where u_1 is the velocity at the inlet of the pipe. For pipes of circular section and diameter d, $m = d/4$. For lighting gas, $c = 130$; for Dowson gas, $c = 64$. Let the temperature be 60° Fahr., or the absolute temperature $T = 521°$. Then $c\,T = 67730$ for lighting gas, and $= 33344$ for Dowson gas. ζ, the coefficient of friction, $= 0{\cdot}003$. Introducing the numerical quantities—

For lighting gas—

$$u_1 = \sqrt{\left\{181{,}700{,}000\;\frac{d}{L}\;\frac{p_1^2 - p_2^2}{p_1^2}\right\}}$$

* Unwin. "Distribution of Power by Compressed Air." "Proc. Inst. Civil Engineers," vol. cv.

For Dowson gas—

$$u_1 = \sqrt{\left\{89{,}450{,}000\;\frac{d}{L}\;\frac{p_1^2 - p_2^2}{p_1^2}\right\}}$$

where the pressures are in lbs. per square inch. When the initial velocity of flow is given, and the terminal pressure is required in terms of the initial pressure:—

For lighting gas—

$$p_2 = p_1 \sqrt{\left\{1 - \frac{u_1^2\,L}{181{,}700{,}000\,d}\right\}}$$

For Dowson gas—

$$p_2 = p_1 \sqrt{\left\{1 - \frac{u_1^2\,L}{89{,}450{,}000\,d}\right\}}$$

Case I.—In an ordinary gas distribution the difference of pressure producing flow is small, being about $2\frac{1}{2}$ inches of water. If $p_2 = 14{\cdot}7$ lbs. per square inch, $p_1 = 14{\cdot}7361$, and

$$\frac{p_1^2 - p_2^2}{p_1^2} = 0{\cdot}00506$$

The equations reduce to

$$u_1 = 959{\cdot}4 \sqrt{\frac{d}{L}} \text{ for lighting gas.}$$

$$= 673{\cdot}2 \sqrt{\frac{d}{L}} \text{ for Dowson gas.}$$

The quantity of gas delivered in cubic feet per hour will be $3{,}600 \times \frac{\pi}{4} d^2\,u_1$. Assume a distribution to a distance of 5,000 feet. Then, with the given pressure difference of $2\frac{1}{2}$ inches of water column, the quantities of gas discharged and its equivalent in power will be as follows:—

A.—Lighting Gas.				B.—Dowson Gas.			
Diameter of Main in inches.	Initial velocity in Main. Feet per second.	Cubic feet of gas delivered per hour.	H.P. at 26·5 cubic feet per H.P. hour.	Diameter of Main in inches.	Initial velocity in Main. Feet per second.	Cubic feet of gas delivered per hour.	H.P. at 90 cubic feet per H.P. hour.
6	9·59	6,782	256	6	6·73	4,758	53
12	13·57	38,350	1,447	12	9·52	26,910	299
24	19·19	217,100	8,189	24	13·46	152,300	1,692
36	23·50	598,000	22,560	36	16·48	419,600	4,662

It will be seen that none of the velocities under this pressure are excessive. The Dowson gas being heavier, the friction is greater and the quantity flowing is less. Further, as the heat value of Dowson gas is less than that of lighting gas, the amount of power transmitted in a main of given size is only about one-fifth as much for Dowson gas as for lighting gas.

Case II.—It may next be inquired what would be the result of using greater pressure to force the gas through the mains than is usual in supply for lighting. In ordinary gas mains it is found inadvisable to increase the pressure because of the increase of leakage. In the distribution of gas for power purposes, this objection would have less weight. The network of mains would be simpler, and the consumers being fewer, there would be fewer joints and valves to cause leakage. By the adoption of some really efficient joint, like that used in the Paris air mains, leakage could be almost reduced to zero. The pressure which would then seem to be desirable for a gas-power distribution is the pressure which would produce in the mains the highest desirable velocity of flow. It may be taken from the analogy of compressed air mains that 45 feet per second is a quite unobjectionable velocity. Assuming this velocity as the initial velocity in the mains, the problem is to find the necessary initial pressure. The equations become—

$$p_1 = \frac{p_2}{\sqrt{\left\{1 - \frac{L}{89{,}730\, d}\right\}}}$$

for lighting gas, and

$$p_1 = \frac{p_2}{\sqrt{\left\{1 - \frac{L}{41{,}180\, d}\right\}}}$$

for Dowson gas.

For a transmission to a distance of 5,000 feet, we get the following results :—

A.—Lighting Gas.

Diameter of Main in inches.	Initial velocity feet per second.	Initial absolute pressure lbs. per sq. inch.	Difference of pressure producing flow. Inches of water.	Quantity of gas. Cubic feet per hour.	Horse-power trans-mitted.
6	45	15·59	24·6	31,800	1,200
12	—	15·12	14·4	127,200	4,·91
24	—	14· 0	5·5	509,000	19,210
36	—	14·84	3 9	1,145,000	43,200

B.—Dowson Gas.

Diameter of Main in inches.	Initial velocity feet per second.	Initial absolute pressure lbs. per sq. inch.	Difference of pressure producing flow. Inches of water.	Quantity of gas. Cubic feet per hour.	Horse-power trans-mitted.
6	45	16·70	55·4	31,800	353
12	—	15·64	26·0	127,000	1,413
24	—	15·15	12·4	509,000	5,655
36	—	15·00	8·3	1,145,000	12,722

Electrical Transmission of Power.

In 1877, Dr. William Siemens indicated the practicability and the probable commercial importance of the electrical transmission of power to considerable distances. In an address to the Iron and Steel Institute, he stated that a copper rod three inches in diameter would transmit 1,000 horse-power a distance of 30 miles. Later in 1883, he delivered a lecture at the Institution of Civil Engineers on the electrical transmission and storage of power. But he was able to describe as practically working transmissions little else than the Lichterfelde and Portrush railways. Deprez had at that time experimentally transmitted 3 horse-power 25 miles, through ordinary telegraph wires, at 2,000 volts, obtaining a return of 32 per cent. only of the energy expended.

It has from that time been hoped that one of the largest fields for electrical enterprise would be, to use the title of Sir W. Siemens's lecture, the transmission and storage of power. Countless predictions have been made in electrical journals that some advance in invention had been accomplished which would revolutionise the conditions of the use of motive power. In these lectures it is necessary to keep to the stable ground of achieved results, and, regarding these alone, the conclusion is unavoidable that the amount of electrical distribution of power actually in operation up to the present time is really comparatively small. Two years ago, Mr. Kapp gave some interesting lectures on the electric transmission of power. In those lectures he describes only a single case of electrical transmission of any magnitude

which was then in operation. That was the installation at Schaffhausen, where about 500 horse-power was being electrically transmitted across the river. Since then, the striking Frankfort Lauffen experiment has been carried out, and power transmitted successfully, and without more than about 25 per cent. loss, a distance of 108 miles. High tension continuous currents from dynamos in series have been used in two or three cases for transmissions to distances up to 28 kilometres. The synchronous alternating method is in operation at Telluride, Colorado, but over a short distance and in favourable circumstances. But when all such cases have been taken into the reckoning, the aggregate power at present transmitted electrically is not very great.

No doubt electrical transmission of power to great distances is possible by more than one method. It is a condition in such a case that a very high tension, 20,000 to 40,000 volts or more, should be used, or the cost is excessive. That such currents will be used seems likely, but can hardly yet be reckoned as accomplished, at least, on a large scale, and with commercial success.

In a great deal that has been said about the electrical distribution of power, one thing has been forgotten. It is, that there have always been means of transmitting power to considerable distances; and if such transmissions are rare, it is not because they would fail mechanically, but because the cost of transmission is too great for profitable application of the power. Motive power was transmitted four miles by compressed air in 1861, before electric transmission was thought of. If electrical transmission is to play an important part, it will only be when it can be carried out so cheaply that the power can be supplied to consumers at a cheaper rate than they can manufacture it for themselves.

In the distribution of electrical energy from central stations for lighting purposes, a great deal has already been accomplished. Financially electric lighting operations appear also to be succeeding, though it is too early to estimate the measure of their success. But a higher price will be paid for energy for lighting than for energy required for power. In towns like Geneva, where electricity can be generated by cheap water power, and where gas costs 7s. per 1,000 cubic feet, the success of electric lighting is assured. In other cases the great convenience of the electric light will no doubt counterbalance some excess of cost when compared with other means of lighting.

In one other case, which is strictly a case of power distribution from a central station, electrical engineers have achieved a remarkable success. In the United States there are now some 4,000 or 5,000 miles of electric tramways, which are working with complete mechanical success. It does not appear that the cost of electric traction is much lower than the cost of horse traction. For one of the oldest and best managed tramways, the West End Street Railway of Boston, the working cost of traction has been given at 22 cents per car-mile for electrical traction, and 24 cents per car-mile for horse traction, the earnings per car-mile being about the same in both cases. But the electric cars attain speeds of 10 to 15 miles an hour, and in American towns, with wide-spreading suburbs, they have great advantages. Almost with no exception—probably the Buda Pesth tramways are the only important exception—the electric tramways which are in successful operation have cheap overhead conductors, carried on posts. Such a system is not suitable for European towns, and with more expensive methods of carrying the conductors, the success of electrical traction is at least more doubtful.

A case where electricity is likely to be used very successfully in transmitting motive power is in working traffic on underground and overhead railways. When passenger trains have to be run at short intervals on a line with numerous stations, electric motors distributed over many carriage axles have great advantages, besides freedom from smoke and steam. It is possible that, even in working cost, the electric motor will be superior to the steam locomotive. But this, again, is a case where cost of power is not a governing consideration, or where, at least, a considerable price can be paid for power.

For both lighting purposes and traction purposes a high price can be paid for power. But when power is distributed for industrial purposes, the question of cost is much more important, and the progress of electrical methods of distribution has been much less rapid. Every electric lighting company would be glad to supply power, if only to increase the day load and so to reduce the idle time of the machines, and in a very few cases power is taken from electric lighting mains. Mr. Shoolbred has stated that in Bradford a few electric motors for hoists, lathes, and other purposes have been fixed. But at 6d. a unit the cost per effective horse-power is £60 per annum (3,000 hours). At that rate the power

can hardly be used except for occasionally worked or intermittent machines. Even if electricity were sold for power purposes at half the price charged for lighting, the cost of the power would be greater than that of steam or gas-power.

When the Niagara Commission met in London, two years ago, there was, the author believes, only a single installation in Europe where power was developed and distributed electrically for motive power purposes to many consumers. That was the interesting work carried out by Messrs. Cuenod Sautter and Company, of Geneva, at Oyonaz, in France. Turbines of about 250 horse-power, at Charmines, generated a continuous current at 1,800 volts, which was transmitted eight kilometres by overhead wires to Oyonaz. There the current was reduced by motor transformers and distributed, partly for lighting, partly for driving motors in a number of small workshops. Nothing could appear more prosperous than this village when the author saw it in 1892. But at that time only about 30 horse-power was distributed for motive power purposes, and about 40 horse-power for electric lighting. About that time the Schaffhausen installation began working, which was described fully by Mr. Gisbert Kapp. That plant was delivering last year about 500 horse-power to one spinning mill. Probably now the power is more widely distributed. A very interesting transmission was erected by M. Hillairet, at Domene, near Grenoble. A turbine of 300 horse-power drives a dynamo at 240 revolutions per minute. This transmits a current at 2,850 volts, by an overhead line a distance of 5 kilometres to a paper mill. In the mill is a motor of 200 horse-power, running at 300 revolutions. The total efficiency of dynamo, line, and motor is 65 per cent.

All the three installations just described have three features in common. The electric current is a continuous current, it is conveyed by an overhead wire, and the source of energy is water-power.

Very probably, in future, alternating currents will replace continuous currents for distant transmissions. It has been decided to use alternating currents, simple or of two phases, for the transmission from Niagara to Buffalo. Alternating current dynamos are free from some of the insulation difficulties which have to be encountered in continuous-current machines, and can be worked probably at tensions impossible for continuous-current machines. If motors for alternating currents can be made simple and self-starting, like continuous-current motors, then the facility of transforming the voltage of the current in a purely statical transformer is an advantage which will give alternating currents a superiority in long distance transmissions. But here again the cost of transformers is a not unimportant factor in determining the feasibility of a transmission. Probably it is only where water-power is available, and in most cases only where cheap overhead transmission is possible that electricity can be supplied at a cost permitting it to compete with other sources of power.

Electric Distributing Mains.—In all distributions of electricity for power purposes to a distance hitherto carried out, except some mining installations, bare conductors carried on wooden telegraph posts have been used. In cases like that at Oyonaz, where the line is carried over fields to a small village, such a cheap method may be used without much objection, even when high-tension currents are transmitted. In that case, however, there is a liability to injury, especially to injury from frost and from lightning, which must be reckoned with. It is fair to point out, that when the cheapness of electrical transmission is put forward as a reason for adopting it in preference to other methods of transmission, it is almost always assumed that such rough and cheap expedients as an overhead conductor on telegraph posts can be adopted. To a mechanical engineer such arrangements do not appear to afford adequate security or permanence for an important power distribution. In proportion as the number of consumers taking power from a common source becomes greater, the inconvenience and damage resulting from any stoppage of the supply of power becomes more serious. Hence it will probably prove to be necessary, if any general system of power distribution by electricity is carried out, to place the conductors in subways where they are protected from injury. Such a construction however will necessarily increase the cost of electrical transmission.

The smallest self-respecting town requiring a water supply would not hesitate to build such a concrete conduit as that shown in Fig. 31. D'Arcy built such a conduit 13 kilometres in length for the water supply to Dijon. It is the smallest conduit accessible throughout. An important electrical power distribution needs permanent and secure construction as much as a system of water supply. An objection is

sometimes made to a subway for bare conductors carrying high-tension currents that there would be danger to life in traversing the conduit. To obviate danger as far as possible the conductors have been placed in recesses. Further, by moveable metal screens, put in connection with a return or earthed conductor, any part of the conduit could be made absolutely safe while repairs or alterations were in progress. The figure shows of course only a sketch of a possible arrangement, but some permanent protection for conductors will have to be adopted in important electrical distributions.

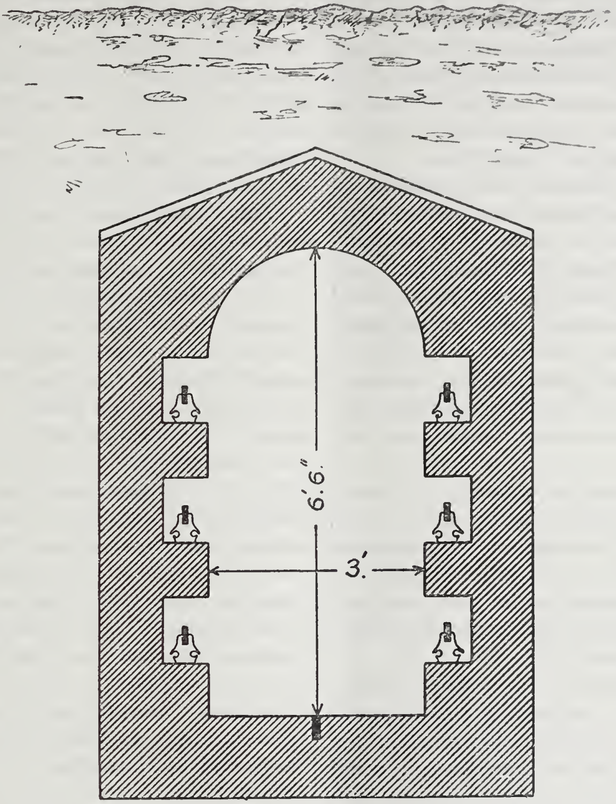

Fig. 31.

The Hersthal Installation.—In 1886, the manufacturers of small arms in Belgium formed a syndicate. To carry out a large order, the society decided on the erection of new workshops with tools of the most modern construction. M. Leon Castermans has given an account in the "Revue Universelle des Mines" of the development of the plans of the works and of the reasons which led to the adoption of electrical transmission.*

The operations to be carried on involved the construction of a number of different factories more or less distant, and so arranged as to be capable of future extension. In these factories it was found necessary to arrange for 13 lines of shafting carrying a total of 200 effective horse-power, or allowing for loss in transmission and engine friction, 300 indicated horse-power. Electric lighting was next decided on, and for this an additional 160 indicated horse-power was required.

It now became a question of driving the different lines of shafting from the steam-engine, and for this some system of transmission had to be selected. The mechanism between the steam-engine and the lines of shafting and belting in the workshops, from which the tools are directly driven, may be termed the intermediate transmission. The arrangements of this transmission are required to subdivide and distribute the motive power, and to effect such modifications of velocity as are necessary. In this intermediate system a gradual subdivision of power must be carried

* "Revue Universelle des Mines," xix. 1892.

out, involving, if ordinary mechanism is employed, a waste of power at each step of the process. The aggregate of these losses is large. It is a special inconvenience of any mechanical system of transmission that no part can be disengaged from the transmission without the use of more or less costly and cumbrous appliances; and hence, practically, when all the machines are not running, a good deal of the transmission is kept running uselessly. Hence, the waste of work which the transmission occasions, when running at full load, is largely increased when only a part of the tools require to be driven.

Two systems of intermediate transmission were first studied, a system of shafting, gearing and belts, and a system of rope transmission. It was found that the moving part only of the intermediate transmission would weigh 40 tons, besides 30 tons of pedestals and other supports. Practically the whole of this would be constantly running, occasioning frictional loss and requiring attention and lubrication, whether much or little work was done.

There is a further inconvenience of such systems indicated by M. Castermans. They do not easily lend themselves to extensions of the works. Either they must be made of excessive size at first, or, when an extension is necessary, they must be removed and replaced by a new transmission.

The study of the waste in ordinary systems of transmissions to such a group of workshops, led to the consideration whether the mechanical intermediate transmission could be replaced by electric transmission, with separate motors to each principal line of workshop shafting.

It was estimated that 260 effective horse-power were required on the 13 lines of shafting. To cover contingencies, motors of an aggregate of 200 horse-power were selected, and, allowing for the loss in these motors, it was estimated that 297 horse-power of electrical energy would have to be transmitted to them. That required a dynamo taking 336 horse-power at the crank-shaft of the engine, or 360 indicated horse-power. The effective work on the driving shaft of the machines is therefore $72\frac{1}{2}$ per cent. of the indicated work of the engine at full load.

The electric system, then, has these advantages:—(1) Simplicity in the transmission between the engine and secondary motors by conductors instead of by shafting and gearing; (2) saving of loss in running an intermediate system of transmission constantly, whether much or little work was being done; (3) greatest efficiency of transmission, even with full load; (4) facility for effecting future extensions with the smallest modification of existing plant.

The system has been carried out very successfully. A steam-engine of 500 horse-power built by Van den Kerchove, running at 66 revolutions per minute, drives the armature of a single dynamo keyed on its crank-shaft. This armature serves as the fly-wheel of the engine. There are two commutators, each taking half the current. The maximum current is 2,440 ampères at 125 volts.

The secondary motors, which drive each a line of shafting, are two-pole motors, with Gramme ring armatures and carbon brushes.

The Hersthal plant has been entirely successful, and there is no doubt that the distribution of the motors, which saves a number of intermediate transmissions, must lead to economy of motive power. But it is fair to point out that this problem of distributing the motive power of large works did not first arise at Hersthal, and can be solved with similar advantages in other ways. It has always been a question, where steam-power only is used, whether it is desirable to concentrate it in a single engine, or to work with each principal line of shafting driven by a separate engine. In dockyards, distribution of power by pressure-water or compressed air has long been practised, from precisely the same motives as those which influenced the engineers at Hersthal. In some large works gas-engines, distributed at various parts of the works, are being adopted to replace the single steam-engine and complex intermediate transmissions previously in use. At Seraing, for 20 years, there has been a distribution of power by compressed air, working motors on individual machines. At Birmingham, in several factories, air motors, involving as little trouble as electric motors, were used to drive small divisions of the machinery, and a large amount of shafting previously in use was removed.

Electric Transmission for Mining Work in Nevada.—An interesting case of the transmission of power electrically is that at the Comstock mines, Nevada. There existed at the mines a ten-foot Pelton wheel driven by water supplied under a head of 460 feet and furnishing 200 horse-power. To obtain additional power the water from this wheel is conducted by two iron pipes down the vertical

shaft and incline of the Chollar mine to the Sutro tunnel level. It is there delivered at a pressure of 680 lbs. per square inch, equivalent to 1,630 feet of head, to six forty-inch Pelton wheels. The jet to each wheel is only five-eighth inch in diameter, and each wheel developes 125 horse-power at 900 revolutions per minute. Each Pelton wheel is coupled to a Brush dynamo, generating current, which is led to the surface, where it drives by dynamo-motors a sixty stamp mill. The Brush motors revolve at 850 revolutions per minute. Of 700 horse-power developed by the Pelton wheels, 435 horse-power, or 60 per cent., is said to be delivered at the motors. The Pelton wheels weigh only 1·8 lb. per electric horse-power.

The Genoa Installation.—Exceptional circumstances have made it possible at Genoa to establish an electric supply in connection with a water supply. Some ten or twelve years ago works for supplying water to Genoa, additional to others then in operation, were constructed. The water is obtained from streams on the Piedmont Liguria frontier, and two large impounding reservoirs have been constructed on the Gorzente river, an affluent of the Po. The reservoirs are 2,050 feet above Genoa, there being a large surplus fall not required as head for the water supply. To relieve the pipes of unnecessary pressure, three relieving or service reservoirs were constructed, reducing to about 600 feet the pressure available for the transmission of the water to Genoa. The first reservoir is near the outlet of a tunnel by which the water is carried through a mountain ridge, and is 360 feet below the tunnel. At that point 730 gross horse-power are utilisable. The second reservoir is 360 feet below the first, and there also 730 gross horse-power can be obtained. The third reservoir is 500 feet below the second, and there 1,000 gross horse-power can be obtained. The water supply scheme has not been entirely successful, and the engineer, M. Bruno, and the consulting engineer, M. Preve, were led to consider the utilisation of the surplus fall to generate electricity, to be transmitted for lighting and power purposes to Genoa, distant about 16 miles.

At the three points described, electric generating stations, named after the Italian electricians, Galvani, Volta, and Paccinotti, are now in operation.

A first installation of a turbine of 140 horse-power was made in 1889, at the Galvani station. This proved successful, and the further development of the stations was undertaken. The Volta station supplies electricity to 15 motors distributed along the valley from Isoverde to Genoa, and to a motor of 60 horse-power at the railway station in Genoa. It also supplies motor transformers at the Central Electric Lighting Station in Genoa. The remainder of the power at this station, amounting to 600 horse-power, is utilised by means of telodynamic transmission. The Volta station supplies electricity for lighting the station of Sempierdarena by a motor of 60 horse-power, driving 12 Siemens' and two Technomasio dynamos, and also supplies electricity for motive power to a number of mills and factories, and the repairing shops of the railway. Messrs. Cuenod, Sautter, and Co., of Geneva, who constructed the electrical plant, have furnished the following details. Messrs. Rieter Brothers, of Winterthur, constructed the first turbines erected. The remainder have been constructed by Messrs. Fæsch and Piccard, of Geneva.

Electrical System.—The distribution is in series at constant current. The generating dynamos maintain a current of constant intensity in a single circuit which traverses all the motors. They supply a constant number of ampères whatever the number of motors at work. The voltage is essentially variable. At certain hours all the motors are out of action. Then the dynamos furnish a current at 450 or 500 volts corresponding to the loss in the circuit. At certain hours both the motors supplying power and the motors driving dynamos for lighting are in action. Then the voltage reaches 5,000 to 6,000 volts.

Galvani Station.—This has a single group of machines, consisting of two Thury continuous current dynamos, coupled by Raffard couplings to a Rieter turbine of 140 horse-power, having a normal speed of 450 revolutions per minute. In addition, a jute factory absorbs the power of two Rieter turbines of 300 horse-power, the power being transmitted to it by telodynamic cables. The generators have six poles and give at full load 47 ampères at 1,000 to 1,100 volts. Their speed varies from 20 to 475 revolutions per minute according to the demand for power. The dynamos are coupled in series and work day and night.

Volta Station.—This has been in operation since 1891. There are four turbines of 140 horse-power each, and eight dynamos working at 47 ampères and 1,000 volts at full load. These generators work at constant speed, and the regulation is effected by varying the exciting current. The regulation is effected by a

single regulator however many generators are in action. The main turbines are Fæsch and Piccard turbines with relay governors, which maintain a strictly constant speed.

The regulation of the exciting current involves difficulties, because the voltage of the main circuit must vary from moment to moment, and sometimes quite suddenly, when motors driven by the current are thrown out of action. The motors are thrown out instantly by short circuiting them. To meet these conditions, the exciting dynamo is driven by a separate 15 horse-power turbine, which has as little inertia as possible. The exciting dynamo has a very light armature, so that it follows instantly the variations of speed of the turbine driving it. The exciting dynamo is itself excited by a small machine serving to light the station, and the stability of its magnetic field is thus independently secured. The turbine driving the exciting machine is provided with a relay governor, but the conical pendulum, ordinarily used to secure constant speed, is replaced by a solenoid holding in equilibrium a soft iron core weighing 33 lbs., which is directly attached to the valve of the relay. A leather belt keeps this core and the valve in rotation, so as to practically annul any frictional effect. A spring and counterweight permit the adjustment of the action of the regulator. The solenoid is traversed by the current in the main circuit, which is normally 47 ampères. If the current augments, the core of the solenoid rises, puts in action the relay, and closes the sluices of the turbine driving the exciter. *Vice-versâ* if the current decreases, the relay opens the turbine sluices.

This system Messrs. Cuenod and Sautter state has given good results. Nevertheless, at the third, or Paccinotti, station, a return has been made to the system adopted in the Galvani station. The regulation is effected by varying the speed of the main turbines, which are constructed with as little inertia as possible, and have no speed regulators.

The Transmitting Arrangements.—The current is transmitted by bare copper wires, $\frac{3}{8}$ths of an inch in diameter, carried overhead on poles, with porcelain and oil insulation. The greatest distance of transmission is 30 miles. The line has a resistance of about 500 volts, or an efficiency at full load of 90 per cent.

The Motors.—The motors are all Thury motors, and are from 5 to 60 horse-power. From 5 to 18 horse-power they are bipolar. Their regulation is effected by shunting, more or less, of the current, and they are all placed in series. Larger motors are multipolar, and these are regulated by displacing, more or less, the points at which the current enters and leaves the motor. This has the effect of reducing the magnetic field, by causing some of the convolutions to be traversed in a direction reverse to the normal. Each motor is governed by a relay, and has a fly-wheel. A lever and counterweight is provided to adjust the governor.

The ratio of the effective work at the motors to the effective work of the turbines is stated to be 72 per cent.

Transmission at Biberist, near Soleure.—Messrs. Cuenod, Sautter, and Co. have also carried out a power transmission between Ronchatel and Biberist. Turbines of 360 horse-power have been erected, and the power is transmitted 28 kilometres to a paper-mill. The generating station has two Thury continuous current dynamos coupled to the turbines by Raffard couplings, and running at 275 revolutions per minute. Each dynamo gives a current of 3,300 volts, and the two dynamos are coupled in series. The current is transmitted by a bare copper wire, one-quarter inch in diameter, on simple porcelain insulators. The receiving station has two dynamos similar to the generators, making 200 revolutions per minute, and driving directly by Raffard couplings the machinery of the mill. An efficiency of 70 per cent. is guaranteed.

The Lauffen Heilbron Transmission.—The single case known to the author of the use of alternating currents for motive power distribution is at Heilbron. The owners of the Wurtemburg Cement Works, at Lauffen-on-Neckar, having surplus water-power, conceived, in 1889, the idea of utilising it to supply electricity in Heilbron, some six miles distant. They accepted plans for using the three-phase current. The Lauffen generating dynamo runs at 4,000 ampères and 50 volts. The voltage is changed to 5,000 by a transformer for transmission to Heilbron, and then reduced to 1,500 for distribution. Part of the current is further reduced to 100 volts in a network for lighting. The charge for current for lighting is 9d. per kilowatt hour. Current used for motors for industrial purposes is charged at 4d. per kilowatt hour, or about £42 per effective horse-power year of 3,000 working hours. This is for current alone, exclusive of interest on the cost of motors. In November last there were on the system 11 motors, aggregating 32 horse-power, a rather insignificant motive power distribu-

tion. So far as the author has had opportunity of judging, the three-phase system with double transformation is an expensive method of distribution. It is worth noting that Mr. C. E. L. Brown, who designed the Lauffen dynamo, speaks doubtfully as to the system. He says that one object of the Lauffen-Frankfort experiment was to show the advantages of the three-phase system for power distribution. But that it actually showed the disadvantages of the system, viz., complication in line, generator, and transformers.

Miscellaneous.

THE PRESENT PROSPECTS OF IPECACUANHA.

The advances that have taken place in the price of ipecacuanha of late in the English drug markets—due, it is said, to the fact of the plant becoming more scarce every year in its Brazilian home—is a matter that brings to mind the attempts made some 28 years ago to introduce the plant into India for extended cultivation. Though in India the ipecacuanha has not made for itself a happy home, the attention given to it by the Indian Government, and the valuable assistance rendered by Kew, have been felt in other parts of the East, with the result that ipecacuanha root now finds its way into the English market from Johore. The history of the single plant sent from Kew, in 1866, is interesting, as showing what may result from small beginnings. From the original plant—which died in 1868—14 other plants were propagated, and the offspring of these, in about three years, amounted to about 400 by further propagation; and, from these and other plants sent to India, the stock increased, in a very few years, to over 6,000. Up to this period, the plants had been propagated by leaf cuttings, but, as plants increased, they were more rapidly propagated by starting small portions of the rhizome, so that in a short time as many as 63,000 plants had been raised. Experience has shown that the plan can be easily propagated, but for extended and profitable culture, India does not seem suited to it; some roots, however, that were grown, dried, and prepared in India in 1876, were used in one of the Calcutta hospitals, and were proved to be equal in medicinal value to the best ipecacuanha grown in Brazil.

Ten years later we find this valuable plant reported as growing in the Straits Settlements "with all the luxuriance of its native country, when a proper situation is hit upon." Though at the date referred to, namely, 1886 or 1887, ipecacuanha was brought into the London market from extensive plantations in Johore, it would seem not to have succeeded since then so well as was anticipated, judging from the fact of the advance in price and the cause to which it is attributed, namely, decreased supply.

In connection with this subject a communication was recently made to the *Chemist and Druggist*, in which a representative of the principal importers of the drug in London gave it as his opinion that one of the causes of the high prices that prevail, and of the inferior quality of the root now generally seen in the London market, was the fact that the plant was "all but exterminated in the districts easily accessible from Cuabayá and the other settlements in the State of Matto Grosso, from which all our supplies are now obtained."

The district upon the frontier of Bolivia is only very imperfectly explored, the soil is marshy, and it is covered with tropical forest. Tribes of savages roam about, and the work of gathering ipecacuanha is neither safe nor pleasant enough to induce the lazy half-castes, the only kind of labour available, to undertake it unless at a very high rate of wages. Ignorant and lazy, these people never take the trouble to leave enough of the plant to give it a chance of growing again, and so season after season they have to go further afield, taking provision with them, and frequently remaining in the marsh for weeks. The collecting goes on pretty well all the year round, and the root dug up is brought to the chief settlement, when it is packed and shipped down the river—a tremendous distance—to Buenos Ayres or Montevideo, about 2,000 miles. Steamers now ply on these rivers, and take about three weeks to accomplish the journey from the upper reaches to the Atlantic port. The freight, is very high, but it is hoped that in a few years' time the railways, which are being pushed inland, will tap this district: and then the drug may be got again from Rio, where it came from many years ago, before the coast regions were exhausted.

Commenting on these facts, particularly on the deterioration of the quality of ipecacuanha, a writer in the *Chemist and Druggist* says:—"The therapeutic value of ipecacuanha, as is well known, is due to the emetine contained in the annulated bark surrounding the ligneous heart of the root; and until about two years ago, it was exceedingly rare to meet with a package containing a greater proportion of wood than what was unavoidably collected along with the drug. But recently there has been an unmistakeable tendency on the part of the collectors to mix with the true drug a varying proportion of absolutely valueless woody matter, probably derived from the procumbent stem. It is hardly possible that they do so ignorantly, but, whatever the cause, they are sure to be themselves the ultimate losers by their want of honesty or care. We have been assured by wholesale druggists that in parcels recently landed the proportion of wood has been as high as 60 per cent., and the druggist, who in former years

could buy good commercial root at 3s. per pound, has now to spend double that amount for an article of which the greater part is unfit for pharmaceutical purposes."

The writer of the above further states that he has examined three separate samples of ipecacuanha, from consignments that had come into the English market, within the last three months, and the first contained 40 per cent. of the genuine drug, 16 per cent. of dust, and pieces too small for classification, which, no doubt, possess a certain therapeutic value, and 44 per cent. of absolutely worthless wood. In the second sample the proportions were 47, 11, and 42, and in the third, 43, 13, and 44 per cent. The results of this examination confirm the complaints of the wholesale druggists—that nearly two-fifths of what is now offered at the drug auctions as ipecacuanha is nothing of the kind.

One of the causes of the depreciation in quality of this and other valuable commodities is pointed out by the writer of the article from whence the above facts are taken in the following remarks:—"One of the mainsprings of the lamentable fact lies, beyond doubt, in the insane haste and greed with which the 'opening-up' of imperfectly organised countries is now being pursued. Nature is certain to avenge herself in time, but for the present the ravage of the South American india-rubber trees, and of all other valuable products of that favoured region, flourishes as unchecked as did the demolition of the cinchona forests a generation ago. Depreciation of quality is the natural consequence of such vandalism."

A paper on the "Ipecacuanhas of English Commerce," by E. M. Holmes, was read at the British Pharmaceutical Conference held at Nottingham in August, and is printed in the *Pharmaceutical Journal* for September 9.

*AN AUTOMATIC GEM-SEPARATOR.**

By William S. Lockhart, M.I.C.E.

The separator described was devised for the purpose of selecting precious stones from the worthless gravel with which they are associated, without the intervention of hand-picking, as now practised, thus avoiding the danger of loss by theft and other disadvantages. In South Africa, Burma, Siam, Ceylon, and other parts of the world, the systems of washing vary to some extent. The earlier stages of these processes would take too long to describe, but all systems resolve themselves finally into the picking over of a concentrated deposit of clean washed gravel for the gems it may contain; and it is at this point that the separator comes in to perform what has hitherto been done by hand. When it is realised that the proportion of gems to worthless pieces of mineral is not a percentage merely, but of one to many thousands, the utility of such a machine is obvious.

The concentrated gravel, when washed, is most carefully classified into sizes, beginning, for diamonds, at one-sixteenth of an inch, and increasing by sixteenths up to five-eighths of an inch, or still further if desired. Each size of gravel is fed into a separator adapted to suit it. The separator has no moving parts, and takes advantage, by means of a stream of water running through it, of the slight variation in specific gravity between the gems (3·5 to 4) and the worthless minerals (2·5 to 3). It is possible to separate such substances by immersing them in a prepared solution of high specific gravity, just as pebbles and chips may be separated in water; but there are practical difficulties about such a process, and the gem-separator described substitutes a moving current of water for the heavier solution, with the advantage that the process is continuous, the separated materials being deposited in their proper receptacles, those for the gems being guarded by locks.

The operations of the machine are not confined to gems. The separation of any minerals from their gangue, providedal ways there is a slight difference in specific gravity, may be effected, and the machine will work on broken material in a dry or merely wetted state, or on slimes run in with a stream of water.

* Paper read at Nottingham before Section G of the British Association, September, 1893.

General Notes.

Lyons Silk Trade.—It appears from a statement in the *Economiste François*, relating to the production of silk stuffs in Lyons and the trade in these articles during 1891 and 1892, that the total production in 1892 amounted to 382,000,000 francs (£15,000,000 sterling) as compared with 357,000,000 francs (£14,000,000 sterling) in 1891. Of the production of 1892, plain stuffs of pure silk and waste silk amounted in value to 156,000,000 francs; pure silks, figured and brochés, 35,500,000; plain silk stuffs, mixed with cotton and wool, 123,300,000; figured silk stuffs, mixed with wool, 24,000,000; stuffs mixed with gold and silver, 4,500,000; crapes of all kinds, 8,500,000; muslins, plain and figured, 3,000,000; gauzes and grenadines, 3,500,000; net and lace, 13,500,000; silk passementeries, 7,500,000; and passementeries of silk mixed with cotton, 3,000,000 francs. As regards the export trade in Lyons products, the amount taken by various countries in 1892, represented by the value in francs, was as follows:—United Kingdom, 116,872,000 francs; Germany, 19,044,000; Swiss, 10,082,000; Italy, 2,475,000; Spain, 3,986,000; Turkey, 7,821,000; United States, 62,635,000; Brazil, 525,000; Argentine Republic, 519,000; other countries, 30,099,000 francs. The value of the exports in 1892 exceeded that of 1891 by 8,000,000 francs.

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Proceedings of the Society.

CANTOR LECTURES.

ALLOYS.

By Prof. W. Chandler Roberts-Austen, C.B., F.R.S.

Lectures I and II.—Delivered March 6 and 13, 1893.

The following pages will form the third series of Cantor Lectures which it has been my good fortune to deliver before this Society. In the first,* the "Alloys used for Coinage" were dealt with, while in the second,† an attempt was made to collect into as concise a form as possible, the main facts connected with the history of our knowledge of the constitution of alloys, and with certain of their industrial applications.

It may be well to devote the present lectures to a consideration of the investigations to which alloys have been subjected during the five years which have passed since the last course was delivered, and it may at once be stated that the progress has not been inconsiderable. This progress is chiefly manifest in two directions. First, much light has been thrown on the particular grouping of associated metals; and, second, new alloys, new associations of metals that is, have been discovered which possess great scientific interest as well as industrial value. In no way has the advance been more marked than in the successful attempts of investigators to connect the behaviour of alloys with ordinary compounds and solutions, more particularly with the solutions of salts, and the success which has been attained may be mainly attributed to the improvements in methods of measuring the high temperatures which are usually required to effect the solution of metals in each other. The whole question of the molecular constitution of alloys is intimately connected with our possession of means for investigating their thermal behaviour during the passage from the molten to the solid state, from the solid to the liquid, and, finally, to metallic vapour. A brief description of the various appliances which can be used in such investigations may, therefore, well be given here, because the gradual development of pyrometry is intimately connected with the history of alloys, and, conversely, alloys have rendered great service in pyrometry. Attention, will, however, be limited to the consideration of those forms of appliance which have either marked distinct stages of advance, or have actually remained in use—it may be with more or less modification—for the purposes of research.

* *Journal* No. 1,651, 1884. † No. 1,873, 1888.

The earliest pyrometers were essentially theromoscopes, and although their graduation presented great difficulties, the importance of being able to measure high temperatures has been recognised for centuries, and it would be difficult to illustrate this better than by a brief record of the testimony which has from time to time been offered by those who have had to apply the heat of furnaces in research or in industry; and it is mainly for the sake of the light incidentally thrown on the progress of research that the following historical notes are offered.

In the 8th century Geber, the chemist, wrote a treatise on furnaces, and showed that he was familiar with the means of applying heat; but he points to the difficulties that are met with in conducting operations at high temperatures, and these he attributed to inability to measure heat, his actual words being, "*sed quoniam non est res ignis, quæ mensurari possit.*"*

The date of the invention of the ordinary thermometer is not well fixed; the conception of the instrument being variously attributed to Drebbel, Santorio, and Fludd; but I gather from a delightful article lent me by my friend, Professor S. P. Thompson,† whose authority in connection with the early history of science is beyond question. that the claims of Santorio‡ are supported by Borelli§ and Malpighi,|| while the title of Drebbel is con-

* From the edition of his works, "Summa Perfectionis Magisterii," published in Venice 1542, p. 28. There is some doubt whether in mediæval translations additions have not been made to Geber's text.

† "Library of Useful Knowledge," Article, Thermometer and Pyrometer."

‡ Comment. in Galen. et in Avicen.

§ "De Motu Animalium," prop. clxxv.

|| "Opuscula Posth," p. 30.

sidered as undoubted by Boerhaave* and Musschenbroek.† Flud repeatedly draws the common air thermometer in his singular work,‡ "De Philosophia Moysiaca."

The earliest air thermometer I can find with a movable index is described by Robert Boyle, and consists of the ordinary glass bulb with a slender stem, in which a globule of mercury moves with the expansion or contraction of the air in the bulb.

In Waller's translation of the proceedings of the Academia del Cimento figures of many other ancient thermometers will be found.

The one here reproduced (Fig. 1) is perhaps the most remarkable. Some readers of this may have shared with me the good fortune to

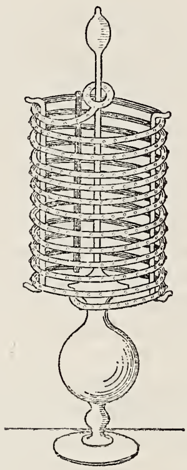

Fig. 1.

have seen the actual instrument, which was exhibited in 1877 at the Loan Collection of Scientific Apparatus.§ It consists of a lower bulb from which a long spiral proceeds and terminates in a smaller bulb at the upper end of the instrument. It is described in the account of the experiments made before the Academia del Cimento, as being "of so exquisite a sense, that the least flame of a candle" affects it.

I have elsewhere called attention‖ to the fact that Boyle alludes to Cornelius Drebbel as having invented "an automatous musical instrument and a furnace which he could regulate to any degree of heat by means of the same instrument."¶

* "Elementa Chemiæ," tom 1, p. 152.

† "Elem. Phil. Nat.," section 780. Tentam Exp. Acad. Cim.

‡ "De Philosophia Moysiaca." Folio. Goudæ. 1638.

§ See Catalogue of the Collection, No. 1828.

‖ "Proc. Roy. Institution," 1892.

¶ "Boyle's Works" (Shaw's Edition), vol. iii., p. 38, 1738.

Space will, however, only permit me to refer to one instrument of singular interest from its relation to later appliances described in this paper. It is a recording thermometer, which appears to have been devised by Dr. Cummings,* of Chester, about the year 1803. It is shown in Fig. 2, in which *a*, represents an

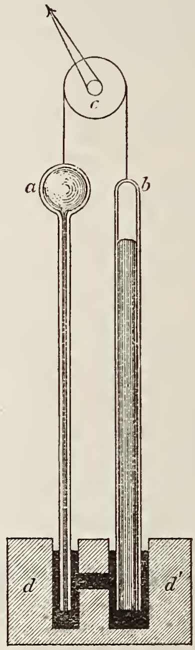

Fig. 2.

air thermometer, and *b*, a barometer suspended from the opposite side of a wheel, *c*, to compensate the influence of variations in atmospheric pressure on the instrument; *d, d*, is a syphon-cistern, in both sides of which the mercury will always remain on the same level; *f*, is an index to which a pencil may be fixed for tracing the variations of the instrument on a plate revolving by means of clock work.

I believe this to be the earliest instrument by the aid of which a time-temperature diagram could have been traced. Mr. Kewley devised an instrument, patented in 1816, in which a differential mercurial thermometer was fixed to the beam of an ordinary balance.

Hitherto thermometers † capable of mea-

* "Library of Useful Knowledge," loc. cit., p. 46.

† We are greatly influenced by heat and cold, and it is perhaps natural that the names of Celsius, of Farenheit, and of Réaumur, which are intimately connected with instruments for measuring variations of temperature, should be prominently remembered, even by unscientific persons, who have but little idea of the real nature of the work of these experimenters. In illustration of the fact that these names are household words, it may be worth while to quote the reply

suring very moderate temperatures have alone been considered, and it is now necessary to turn to the consideration of true pyrometers, or instruments capable of indicating temperatures beyond the range of the ordinary mercurial thermometer. I have not found reference to earlier work than that of Sir Isaac Newton,* who, in 1701, applied his law of cooling to high temperatures, and, in notes which accompany his *Scala graduum caloris*, showed that he knew that the freezing-point of lead differs slightly from its melting point.

Amontons made similar experiments in Paris at about the same time. Musschenbroek's pyrometer was constructed in 1731. He employed the expansion of a metallic rod for indicating the temperature to which the rod was raised. An early copy of his instrument was exhibited at the Loan Collection of Scientific Apparatus, 1877, and was, undoubtedly, one of the oldest of its kind.† Very many instruments of similar construction followed, but these must be passed over, as the principle on which they depend has practically been abandoned in accurate modern pyrometry. Reference must, however, be made to Josiah Wedgwood.‡ The measurement of the contraction of clay at high temperature was the basis on which his instrument rested, and, in communicating a description of it to the Royal Society, we find him, a thousand years after Geber had held that "fire cannot be measured," still lamenting the want of suitable instruments, saying "How much it is to be wished that the authors (to whom he refers) had been able to convey to us a measure of the heat made use of in their valuable processes; . . . a red heat, a bright red, and a white heat are," Wedgwood adds, "indeterminate expressions, and even though the three stages are sufficiently distinct from each other, they are of too great latitude, and pass into each other by numerous gradations which can neither be expressed in words nor discriminated by the eye."

given by a youthful candidate to the question, "Describe any way in which the velocity of light has been measured." The answer, which Dr. Oliver Lodge ("Literary Blunders," by H. B. Wheatley, 1893, p. 185) assures us was actually given, is as follows:—"A distinguished but heathen philosopher, Homer, was the first to discover this. He was standing one day at one side of the earth looking at Jupiter, when he conjectured that he would take sixteen minutes to get at the other side. This conjecture he then verified by careful experiment. Now the whole way across the earth is 3,072,000 miles, and dividing this by 16 we get 192,000 miles a second... .....P.S.—I think the gentleman's name was Romer (Reaumur), not Homer; but any way, he was 20 per cent. wrong, and Mr. Fahrenheit and Mr. Celsius afterwards made more careful computations."

* "Phil. Trans. Roy. Soc.," vol. xxii. p. 824.

† It was constructed after the description and drawing given on p. 12, table xxx. of Musschenbroek's "Tentamina Experimentorum Naturalium," Lugduni, 1731. Par. II.

‡ "Phil. Trans. Roy. Soc.," vol. lxxii. p. 305.

Guyton Morveau (1808) saw the value of this appliance, and strove to reconcile the discrepancies which were discovered in working it. As regards date, the physicist who next deserves mention is Antoine César Becquerel;* his contributions to electro-pyrometry were very noteworthy. In 1826 he used various thermo-couples, especially one of platinum and palladium, and he showed that even two wires of platinum of different manufacture could be employed. He actually measured, with the aid of a thermo-couple of fine wires, the temperatures of different portions of a luminous flame, and he fully recognised that when iron is used as one element of a thermo-couple, its behaviour is abnormal. His couples were simply joined without solder.

Prinsep† was the first to use an air thermometer with a metallic bulb. He was the Assay Master of the Mint at Benares, and appears to have been struck by the necessity for measuring variations in the temperature of the muffle used in assaying. He says, "the disparity of heat in different parts of the same muffle is greater than might have been supposed;" and, in view of the importance of the operation of assaying, he points out that "it would be useful to know every difference in this respect." Prinsep had already attempted to determine high temperatures by the use of a graduated series of alloys of gold and platinum—a method which is still in use—and he suggested the adoption of an optical pyrometer, in which the relative intensity of light from various sources was measured by interposing plates of brown mica between the eye of the glowing body.

In 1836 we come to Pouillet, whose work, Barus, a distinguished authority on pyrometry, justly says, is of prime importance. He constructed an air thermometer, with a bulb of platinum, which enabled him to work at very high temperatures. "He took the first definite step in radiation pyrometry, by investigating the temperature at which solids glow; in calorimetric pyrometry, by determining the specific heat of platinum between 0° and 1,200°; and in thermo-electric pyrometry, by carefully calibrating a thermo-couple of

* "Ann. de Chim.," vol. xxxi., 1826, p. 371.

† "Phil. Trans. Roy. Soc.," 1828, p. 79.

platinum and iron."* In accepting this just tribute to Pouillet's work in thermo-electric pyrometry, we must not forget the earlier labours of A. C. Becquerel.

Pouillet's paper† is interesting reading, but it will be quoted here for the sake of its incidental references to practical work. He clearly shows that he suspected that gases are absorbed by platinum, and thus anticipates much later work; while, as regards the industrial value of the thermo-couple in pyrometry, he says:—"This pyrometer offers the advantage of being a really practical instrument, and its sensibility augments as the temperature rises. When it is graduated by the air pyrometer, it is suitable for indicating, with great exactitude, the temperature of any furnace provided it is below the melting point of iron, that is, below the melting points of one of the elements of his couple." The facts stated in this sentence are, after a lapse of more than half a century, being generally accepted.

Joule‡ saw how useful the thermo-couple would be as an instrument of research, and actually employed a copper-iron one for measuring the heat which is evolved when a bar of metal is subjected to tensile stress. The early use of a thermo-couple for such a purpose is so interesting that a sketch from Joule's paper is given in Fig. 3, and shows the

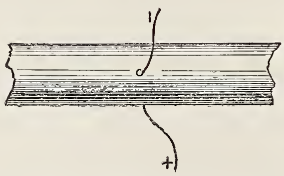

FIG. 3.

way the thermo-couple is inserted in the test-piece. With reference to the use of iron in a couple, it may be observed that Edmond Becquerel§ appears to have been aware that there was a critical point in iron, for he abandoned the use of the iron-platinum couple because he found that the indications were disturbed between a temperature of 500° and 700°. We now know that one critical point in carburised iron does lie between these temperatures. He finally adopted the platinum-palladium couple, and his determinations of the melting points of silver (960°) and of gold (1092·2) show less divergence than those of other experimenters from the figures now accepted.

Returning to Pouillet's work, it should be observed that the interdependence of the indications afforded by the air thermometer and by the thermo-couple, is the basis of much work that followed. The air thermometer and the thermo-couple may really afford concurrent and equally trustworthy testimony in the measurement of high temperatures, but the difficulty of obtaining this testimony gave rise to the long controversies between E. Becquerel, who used the thermo-couple, and Deville and Troost, who advocated the adoption of the porcelain-bulb air thermometer. The discussion concluded with the graceful words of the latter physicists.* "Nos nouvelles déterminations de la température d'ebullition du cadmium et du zinc, au moyen des thermomètre à air, sont presque concordantes avec les nombres qui ont été publiés par M. Edm. Becquerel, et cet accord avec ce savant physicien nous donne quelque confiance dans les expériences dont nous publions plus haut les résultats."

Let the reader study the classical work of Deville and Troost conducted with the air thermometer between the years 1863 and 1880, comparing it with the admirable researches of Edm. Becquerel, and then turn to a recent paper by Professor Barus† on "The Calibration of the platinum, iridio-platinum, thermo-couple,"‡ by the aid of a porcelain-bulb air thermometer of refined and elaborate construction, and it will be evident how greatly scientific progress would have been promoted if the accuracy of the views of A. C. Becquerel and of Pouillet had been verified earlier. There was much intermediate work of great interest in this period, 1863-1880, of which space will not permit a detailed account to be given. It is, however, impossible to be indifferent to the scientific progress which was made in the early part of this critical period in the history of pyrometry. A picturesque and almost romantic incident is connected with the work of J. J. Waterston, and it has been well described for us by Lord Rayleigh who found a paper, by Waterston, in the archives of the Royal Society, in which he clearly enunciated

* Barus, "United States Geological Survey." Bulletin 54, 1889.

† "Comptes Rendus," vol. 3, 1836, p. 782.

‡ "Phil. Trans," vol. 149, 1859, p. 91.

§ "Comptes Rendus," vol 1, 1835, p. 28. *Ibid*, vol. 58, 1863, p. 49.

* "Comptes Rendus," vol. 90, 1880, p. 777.

† "Phil Mag," vol. 34, 1892, p. 1, and *ibid.*, p. 376.

‡ This couple was first used in 1873 by Tait. "Edinburgh Roy. Soc. Trans." vol. 27, 1873, p. 125.

in, pre-Maxwell days, the Kynetic theory of gases. I have referred to Waterston because the fortunate circumstance of his having had, as he says, "to graduate a water thermometer"* appears to have led him to the singularly advanced view that "the ultimate molecule, as an integral part of a gas or vapour, is capable of subdivision." "It is daily becoming manifest," he adds, "that the elementary molecule, though minute beyond conception, is to be studied as a microcosm essentially dynamical in its internal constitution, its apparently statistical condition being simply the antagonism of transcendant *vis viva* potents." He points to the fact that "the forces at the command of the chemist are insignificant in comparison to the heat and pressure with which the elements of matter have to contend in the body of the sun." Surely a very remarkable sentence since justified, not only by Lockyer's work, but by the abandonment of iodine vapour in pyrometry which followed Victor Meyer's evidence as to its being dissociated at high temperatures.

A new phase in the history of the measurement of high temperatures began with the work of Sir William Siemens, who showed that the variations in the electrical resistance of a heated metallic conductor would afford a pyrometric method. The names of Muller, Quincke, and Ressig may be mentioned in connection with early work in this direction, but Siemens was the first to demonstrate the practical nature of the method. The first notice I can find of his experiments is given in a letter to Dr. Tyndall, dated December, 1860. Twelve years later, in a lecture delivered before the members of the Royal Institution,† Siemens makes some interesting remarks on the industrial aspect of pyrometry as limited by capabilities of the mercurial thermometer. He said, "when we ascend the scale of intensity, we soon approach a point at which mercury boils, and from that point upwards we are left without a reliable guide; and the result is, that we find in chemical books on chemical processes, statements to the effect that such and such a reaction takes place at a 'dull red,' such another at a 'bright red,' or a 'cherry red,' or a 'white heat,' expressions which remind one," he adds, "of the days of alchemy, rather than chemical science at the present day." With reference to this it may observed that if, as Sir William says, technical men "were left without a reliable guide" directly the limits of the mercurial thermometer were passed, it was their own fault. The thermo-couples proposed by Becquerel and others would have given them trustworthy measurements of high temperature, but they either lacked knowledge of the sources of information, or the skill to use the far from complicated appliances at command. An excellent dead-beat galvanometer, so essential in connection with all pyrometric methods of which electricity is the base, was long ago provided by Sturgeon; but metallurgists, who sadly needed a good pyrometer, were either ignorant of the existence of such physical instruments, or untrained in their use, and are now only beginning to recognise the necessity for their adoption.

The nature of Siemens's instrument may be made clear by the accompanying diagram (Fig. 4). A divided current passes from the

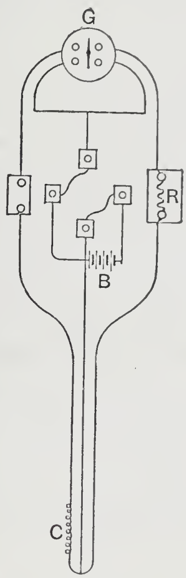

FIG. 4.

battery, B, to a platinum wire, C, coiled round a clay cylinder, and to a resistance coil, R. At the ordinary temperature, the resistance of the platinum coil is balanced by the standard resistance, R. If, however, the platinum coil be heated, the resistance will be increased, and this increase of resistance, which can be measured in various ways, indicates the temperature of the coil, C. The coil itself may be adequately protected and exposed to temperatures, which have been determined by the air thermometer: the deflection of a suitable (differential) galvanometer, G, will then

* See his paper, "Phil. Mag.," 1863, vol. xxvi. p. 116.
† "Pro. Roy. Inst.," vol vi. p. 483.

indicate temperatures directly. For instance, the temperature at which zinc boils has been accurately fixed at 940° C., and if the coil is heated in the vapour of boiling zinc, the angle through which the galvanometer mirror is deflected marks the temperature of 940°C.

For many years this electrical-resistance pyrometer was the only appliance, believed to be trustworthy, which could be placed in the hands of artificers. Its usefulness was widely recognised, and a Committee of the British Association was appointed to report upon it. The result of the inquiry* rather tended to shake confidence in the instrument, as it was shown that it was liable to changes of zero. Mr. H. L. Callendar† has, however, done admirable service by proving that, with certain precautions, the method may be rendered trustworthy. He winds the platinum wire on a plate of mica, excludes reducing gases, as the Committee suggested, by enclosing the coil in a tube of doubly-glazed porcelain, and uses a zero method of measuring the current with the galvanometer.

It will have been evident from what has been already adduced with reference to the works of the Becquerels and of Deville that by the year 1880 two main systems of pyrometry had been well established, these depended respectively on the use of the air thermometer and of thermo-couples. Siemens's electrical pyrometer, though its utility was admitted, was expensive, and confidence in it was not established. The basis of optical pyrometry had been firmly laid, but the measurement of high temperatures by optical methods had not passed into the domain of industrial work.

The publication of the article "Pyrometry," in the last edition of the "Encyclopedia Britannica," in 1886, enables us to judge what progress had been attained at the period when this important work appeared. In 1886, the author of that article, Mr. N. Shaw, who is so eminently qualified to form an opinion, took a distinctly gloomy view of pyrometry. He concludes his excellent article by suggesting doubt whether any of the instruments he describes "can be easily made to take up the temperature of the body or enclosure under investigation," and he points out that "perhaps the most important modern attempts at the development of pyrometry are those connected with the identification of the law connecting the temperature with the amount and nature of energy which it radiates, for on such attempts depends the possibility of measuring the temperature of a hot body by means of the light it emits" . . . . and he adds that, "at present there is no general agreement between scientific men as to the form the relation takes." In 1886, the year Shaw wrote, the beginnings of very distinct advances in practical pyrometry were made. Callendar published the first part of the work that are subsequently developed in his well-known paper,* which restored confidence in the electrical-resistance pyrometer. In the following year, Professor H. le Chatelier† communicated a paper to the Chemical Society of Paris on the platinum, platinum-rhodium thermo-couple, which gave an entirely new and vigorous impulse to thermo-electric methods of pyrometry, as the form of thermo-couple he employed takes up the temperature of the locality in which it is placed with astonishing rapidity; and Barus established the thoroughly trustworthy character of the platinum, platinum-*iridium* couple, and devised a very ingenious pyrometric method depending on the viscosity of gases.

Fig. 5 represents, somewhat diagrammatically, the arrangement of Callendar's apparatus.‡

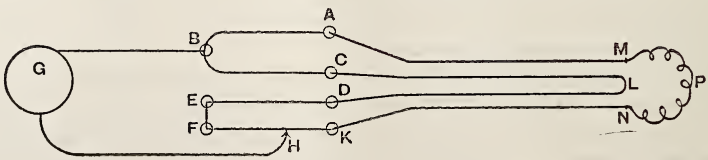

FIG. 5.

A B, B C, are equal resistances, forming the arms of the balance. The battery is connected at A and C, and one terminal of the galvanometer, G and B; D E represents a set of resistance coils, which, together with the resistances, A B and B C, may be supplied by an ordinary box of coils

* "British Association Report," 1874, p. 242.

† "Phil. Trans. Royal Soc.," vol. clxxviii. 1887, p. 161., and subsequent papers in the "Phil. Mag." and "Proc. Roy. Soc."

* "Phil. Trans. Roy. Soc." loc. cit.

† "Bull. Soc. Chim." Paris, vol. xlvii., 1887, p. 2; "Journal de Physique," vol. vi., 1887, p. 23.

‡ "Phil. Magazine," vol. xxxii. 1891, p. 104, and vol. xxxiii. 1892, p. 220.

of the "post-office" pattern. F K represents a straight bridge wire, with a divided scale attached. The other terminal of the galvanometer is connected to the contact-piece, H, which slides along this wire. The leads, A M, K N, from the pyrometer coil, P, are connected to A and K; and the compensating leads, C L, L D, the resistance of which is equal to A M, K N, are connected to C and D. These four leads may be of any convenient length; they are symmetrically arranged, so that corresponding parts are always at the same temperature. When the balance is found by inserting suitable resistances in the arm, D E, and sliding the contact-piece, H, it is plain that, since the resistances, A B, B C are equal, the resistance of the pyrometer and its leads, together with that of the length, H K, of the bridge-wire, will be equal to the remaining portion, F H, of the bridge-wire, together with the coils, D E, and the compensating wires, C L D. Thus, the changes of the resistance of the pyrometer-leads, A M, K N, are compensated by the equal changes in the leads, C L, L D, and the resistance of the pyrometer - coil itself is directly given by the sum of the coils, D E, and the reading of the bridge - wire. The resistance of a centimetre of the bridge-wire, F K, is made to correspond to such an increase of the resistance of the pyrometer coil, P, as is produced by a rise of 1° C. The contact key, H, slides along this wire, and the galvanometer can easily be made sensitive to one-hundredth of a centimetre of this bridge-wire; so that one - tenth of a centimetre, which corresponds to one-tenth of a degree, can, of course, be measured with certainty. The author has worked for several days at the Royal Mint with Mr. Callendar, and is satisfied that, at temperatures exceeding that of bright redness, the comparative readings are accurate to one-tenth of a degree. This would have been considered impossible a few years ago. and the statement will, perhaps, be received with some incredulity. Later on, evidence will be examined which leads to the belief that, in the measurement of a "white-heat," degrees of value similar to those of the ordinary mercurial thermometer are still employed.

The reader will, however, remember that measuring the increased resistance of a heated conductor is not the only way in which electricity has been made serviceable in the measurement of high temperatures. It has long been known that if a junction of two metals be heated, the electrical equilibrium of the system is disturbed, and the measurement of the difference of potential produced affords a means of estimating the temperature of the junction. The use of such thermo-junctions appears, as has already been stated, to have been suggested by A. C. Becquerel in 1826, and adopted by Pouillet ten years later. Unfortunately, the metals composing the thermo-junctions were badly chosen, and their use was consequently greatly retarded until, as already stated, within the last few years, Professor H. Le Chatelier, of Paris, advocated the use of platinum, in conjunction with platinum alloyed with ten per cent. of rhodium. The author first adopted this couple in 1889, and has since constantly used it, in conjunction with a photographic recorder, devised for the purposes of an investigation which was entrusted to him by the Institution of Mechanical Engineers. This instrument will be described presently. In its latest form, the couple consists of two wires, one of platinum and the other of platinum-rhodium alloy, mentioned above, simply twisted at their ends or soldered with gold, and connected with a dead-beat galvanometer of about 200 ohms resistance. The Deprez and D'Arsonval form of galvanometer, particularly the latest type of this instrument, is admirably adapted for use with the thermo-couple.

A photographic method was employed as early as 1887 by H. le Chatelier* in connection with his thermo-couple. It consisted in allowing the image of induction sparks, produced at regular intervals of time, to fall on a narrow fixed sensitised strip of glass. If the temperature to which the thermo-couple is exposed is rising or falling at a uniform rate, the photographic images of the sparks will be equidistant, but if there is at any moment an arrest in the rise, or fall, of the temperature the images of the sparks will then be closer together. The distance between the individual lines affords a method for measuring the rate at which a thermo-couple receives or loses heat from any hot locality or substance in which it may be placed.

The new departure in pyrometry, by which curves are automatically obtained, will now be described. It will be obvious that by confining the image of the mirror to a minute spot, and by moving the sensitised plate at a uniform rate, a time-temperature curve may be traced by the aid of photography. Such curves are often very beautiful,

* "Comptes Rendus," vol. cxiv., 1887, p. 1443.

and I have elsewhere shown* that they may yield results of much importance.

The arrangement, which is shown in Fig. 6, consists of a galvanometer of the Deprez and D'Arsonval type enclosed in a large camera; a fixed mirror, F, is placed below the movable mirror, M, of the galvanometer, so that the light from the lime cylinder, L, reflected in the mirror, H, passes to both mirrors, F and M, and is reflected in the direction of a fine horizontal slit, A B; behind which a sensitised photographic plate, C, is drawn vertically past the slit, by means of gearing, D, driven by clockwork. The ray from the fixed mirror is interrupted periodically by the vane, E, and a beaded datum - line is given, which enables any irregularity in the advance of the plate to be detected.

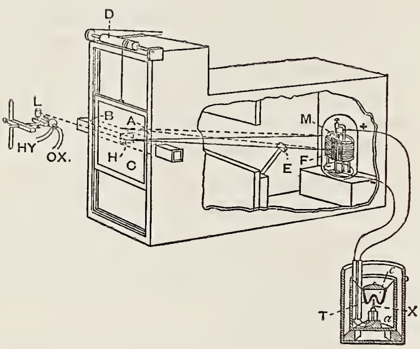

FIG. 6.

The amount of divergence, from its datum-line, of the spot of light reflected by the movable mirror at any given moment, bears a relation (which can readily be found by calibration) to the temperature to which the thermo-junction, X, is heated; and the variations of temperature will be indicated by a curve, which is the resultant of the upward movement of the plate and the horizontal movement of the spot of light. A crucible *c*, which may be filled with molten metal, is provided with a tubulure T for the insertion of the thermo-junction. The crucible is suspended by wires in a double jacket of tin plate, *a*, *b*.

The author is satisfied that this thermo-junction can afford trustworthy results, accurate to 1°, at temperatures of over 1,000° Centigrade. One important feature of the appliance is the minuteness of the space occupied by the thermo-junction, which may be suitably protected, and inserted into the midst of a very small mass of metal. The pyrometer is calibrated by exposing the thermo-junction to certain known temperatures, such as the solidifying points of salts or metals. There is no difficulty in recognising the melting or solidifying points; for, as the mass passes from the solid to the fluid state, the temperature remains constant for a brief period, the duration of which depends on the amount of material operated upon, and its latent heat of fusion; the result being that the spot of light from the galvanometer will be arrested, and the position on the scale at which it stops marks the temperature to be determined. A detailed drawing of a more elaborate form of this appliance is given in Fig. 7, p. 985.

The appliance consists, as is shown in the accompanying plate, of a camera about five feet long, in which a galvanometer may be placed in either of two positions, according to the range of temperature to be observed. This camera has three doors, and is made separate from the portion of the apparatus which contains the moving photographic plate, C. The two parts are connected by a flexible leather "bellows" junction, G, the object being to enable the plane of the sensitised plate to be adjusted at right angles to the rays of light from the galvanometer mirrors, F and M. Inside the camera is a focussing tube, T, containing a lens, L, which receives the light from the mirror, H, and transmits it to the mirrors, F and M. One of these mirrors, M, is movable, and is carried by the coil of the galvanometer; while the other, F, is carried upon an adjustable arm fixed to the supports of the galvanometer, its function being to send a ray of light from the mirror, H, to the slit, A B, and thus to trace a datum line as the photographic plate travels upwards. The temperature is recorded by the variations in the position of the spot of light received from the mirror, M. There is a screen, S, to cut off light reflected from the brass work of the galvanometer. The end of the tube, T, is provided with an adjustable brass slit, O, by means of which the width of the photographic traces on the plate may be varied. The mirror, H, is mounted on a block, which can be adjusted so that external light may be received from either side. The focussing of the lens, L, may be effected from outside the camera. Plug connections are provided for at the top of the instrument, and the wires, *a*, *b*, connect the galvanometer with a thermo-couple, J, placed in the furnace or other source

* "Proceedings Roy. Soc.," vol. xlix., 1891, p. 347; vol. l., 1892, p. 367. "Proceedings Institute of Mechanical Engineers," 1891, p. 543 and 1893, p. 102.

of heat. The photographic plate is secured to its carrying-slide, C′, by means of little cams; and this carrier is enclosed in a case, K, provided, with a light tight door, I. The case, K, is held in position by a pin, P. The connection of the photographic plate with the

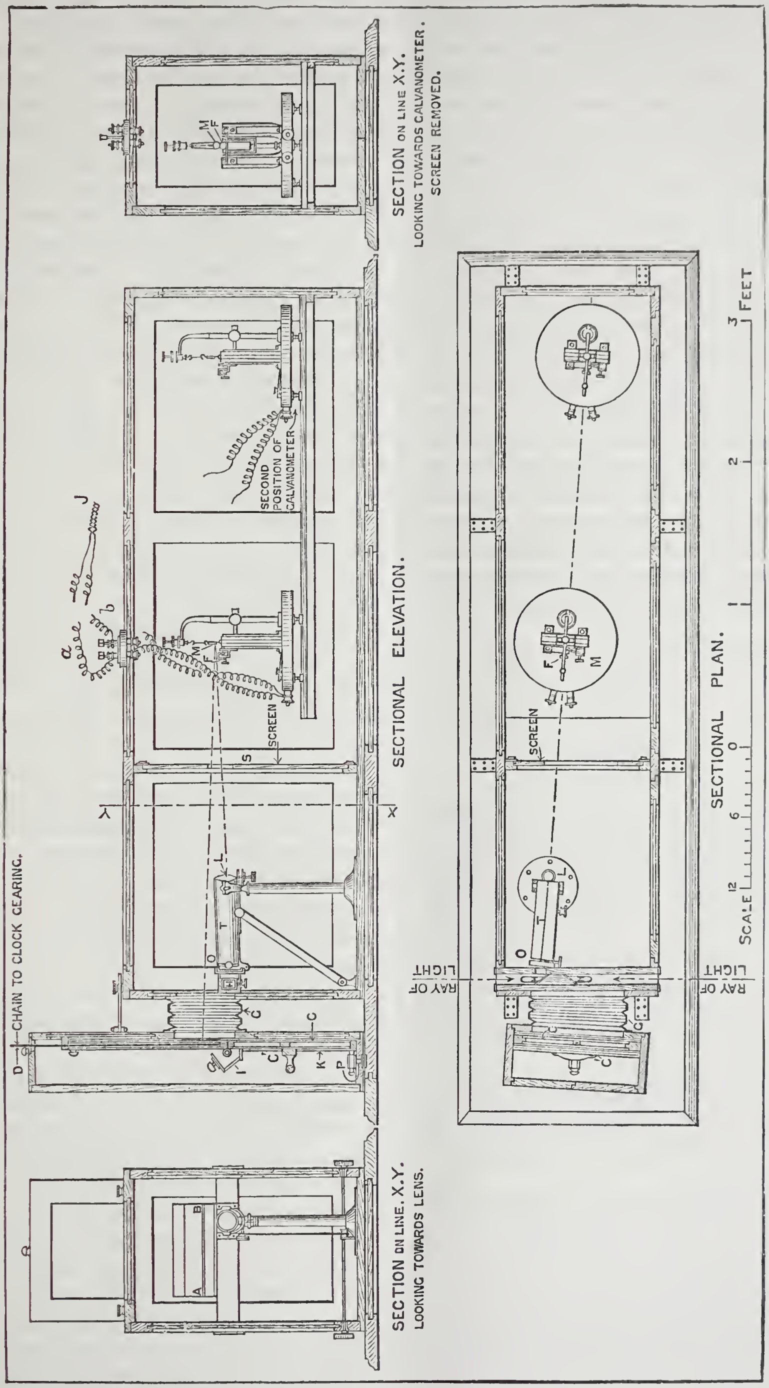

Fig. 7.

driving clock is shown at D. It may be mentioned that the galvanometer stands on three plates, which provide the well-known combination of the hole, slot, and plane, to ensure

steadiness. If the sensitised plate be replaced by a revolving drum bearing photographic paper, it will be obvious that a time-temperature curve of considerable length can be readily obtained; and such curves afford convenient records of the variations in the temperature of any furnace, or other source of heat, in which the thermo-couple, J, may have been placed.

The question now arises how are these instruments calibrated? To describe the methods at length would demand more than a single lecture, and the reader may well consult the papers to which reference is given.* It should be stated, however, that the calorimetric method of Violle has enabled the melting points of general refractory metals, such as silver, gold, palladium, and platinum, to be determined, and these have afforded a secure basis for the work of calibration. The classical work of H. St. Claire-Deville, and Troost with the air thermometer, to which reference has already been made, has rendered splendid service by enabling us to measure accurately high temperatures, and to state the results in the degrees of the ordinary thermometric scale.

The most useful data to bear in mind are:—

The melting point of zinc	415°C.
,, ,, ,, ,, aluminium	625°
,, ,, ,, ,, silver	954°
,, ,, ,, ,, gold	1,045°
,, ,, ,, ,, palladium	1,500°
,, ,, ,, ,, platinum	1,775°

By suitably protecting either the thermo-couple or the Callendar resistance coil (Fig. 5), and surrounding them by masses of any of these metals it is not difficult, provided care be exercised, to determine the points at which they either "freeze" or melt, and thus to calibrate the instruments, but such experiments demand much skill and familiarity, both with working at high temperatures and in manipulating the precious metals.

There are various other pyrometers, but they are better suited for industrial work than for the purposes of research, and will therefore not be described here.

Of all the varied pyrometers, much may be said in favour of the electrical ones, which involve the use of the galvanometer. It will have been evident that, in the case of either of them, the spot of light from the mirror may be received on a sensitised plate, and very slight variations of temperature can then be recorded automatically. As regards the two electrical methods, much advantage may be claimed for the one that depends on the use of a thermo-couple, which is, itself, very small, and if injured, can be readily replaced. It can, moreover, if suitably protected, be placed in the midst of a few grammes of metal which is being submitted to thermal treatment. The little mass of metal may not be heated beyond redness, or the operation may involve its fusion and volatilisation, but a permanent record can be obtained of minute changes in the behaviour of the metal, if they are marked by the evolution or absorption of heat such as accompany the passage of a metal or alloy from a normal state to an allotropic one. The various phenomena of fusion and solidification can also be faithfully recorded, whether they occur either in the centre of a twenty-ton ingot of steel, or in a tiny mass of gold. On the other hand, the little pyrometer may be placed in the blast mains of an Iron or Steel works, and will furnish the manager with precious information and a trustworthy record of the variations of temperature in the torrents of hot air which pass over the thermo-couple on the way to the seething contents of the furnace.

It remains to be seen what use may be made of this powerful weapon of research in conducting investigations into the nature of alloys.

In employing the thermo-couple for studying the molecular grouping of alloys, it is necessary to bear in mind what would happen if an ordinary mercurial thermometer is plunged into water which is losing its heat to a cold environment. The mercurial column would, as is well known, fall until the water begins to freeze, and then the mercury remains steady until the whole of the water is frozen. The latent heat of the water is gradually liberated during the solidification of the forming ice, and the thermometer ceases to indicate a fall in temperature until the work of solidification is complete. The case is precisely the same when a metal is cooled down to its freezing-point. Suppose the thermo-couple is in connection with the autographic recorder (Figs. 6 and 7), and is suitably protected—though this is not absolutely necessary—and is plunged into the midst of a little mass of fluid gold—some 30 grammes will suffice—which is being slowly cooled. The photographic curve registered by the recorder will be that shown in Fig. 8. Assume that the initial temperature of the cooling mass of gold is 2,000°, the temperature will fall, and the curve registered

* Roberts-Austen, "Proc. Inst. Civil Engineers," vol. cx., 1892. (Violle) "Comptes Rendus," vol. lxxxv., 1877, p. 543; vol. lxxxix., 1879, p. 702; vol. xcii., 1881, p. 866.

on the sensitised plate by the spot of light will, when the temperature of 1,045° is reached, suddenly become approximately horizontal, as at A, and will remain horizontal until the mass of gold is solid, and then, but not until then, it will resume its downward course to the point at which the little mass reaches the atmospheric temperature. The same effect would be produced if the thermo-couple was placed in any other metal—lead, silver, platinum, or palladium—but in the case of silver and lead, the couple must be protected by clay from the direct action of the metal.

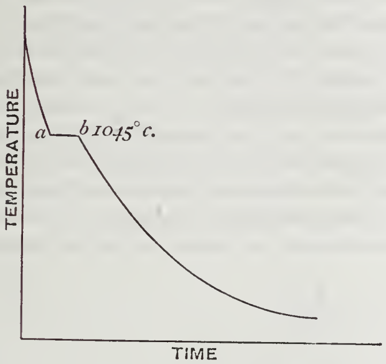

FIG. 8.

Hitberto we have only considered the case of a pure metal, but directly the mass is alloyed with even a minute quantity of another metal, quite a different set of molecular conditions is established, respecting which the autographic curves enable most precious information to be gathered. In fact, the purer the metallic mass is, the sharper will be the angle made by the horizontal portion of the curve, *a*, *b*, with the portions above and below it. The presence of an added element, even though its amount be apparently insignificant, is quite sufficient to destroy the sharpness of the freezing point of any metal which has as yet been examined. If the added metal is present in a very small quantity it apparently remains free, and usually lowers the freezing point of the mass, as will be hereinafter explained, but when a certain proportion of the added metal has been reached, it unites with a portion of the mass, and certain alloys, or groups of alloys are formed which fall out of solution as the mass cools, and the result is to change the nature of the cooling-curve, rounding its angles, and, in extreme cases, obliterating the horizontal part altogether. Such an extreme case is presented when two-tenths per cent. of aluminium is added to gold (Fig. 9). The horizontal part of the curve is practically obliterated, that is, there is no true freezing point. The normal curve for freezing gold would have followed the line (*a*, *c*), but the curve of

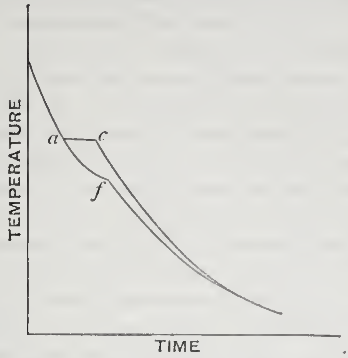

FIG 9.

gold, with two-tenths per cent. of aluminium, is that shown at *a*, *f*, with only a faint indication of the freezing of the mass, as a whole, at *f*.

In this experiment the addition of only a small quantity of an added metal has been considered, and that from a somewhat limited point of view. The conditions are widely different, when the added metal forms a large proportion of the mass to which it is added. The case of the aluminium-gold alloys is very instructive. Suppose the apparatus shown in Figs. 6 and 7 to be so arranged that a series of cooling curves could be taken of alloys, in which the amount of aluminium added is considerable. Starting with pure gold, having a freezing point at 1,045°, successive additions of aluminium lower the point, and destroy the yellow colour of the gold, until the alloy containing 90 per cent. of gold and 10 per cent. of aluminium is reached, the freezing point of this alloy is 628° or 417° degrees less than that of pure gold but then with further additions of aluminium the curve turns, the freezing points begin to rise, and when the amount of alumium reaches 21·6 per cent., the freezing point is actually a few degrees higher than that of gold itself, and the alloy is a brilliant ruby colour. After this point is passed, successive additions of aluminium again lower the freezing points, and they appear to be lowered gradually until the freezing point of pure aluminium is reached. The case of the aluminium-antimony series, investigated for Dr. Alder Wright by the author, presents a similar case. Dr. Wright observed that the melting point of the alloy, containing 18·7 per cent. of aluminium and 81·3 per cent. of antimony, is considerably higher than that

of its least fusible constituent the aluminium (625°). Accurate measurement by the aid of the curves, obtained in the way which has been already indicated, showed that the alloy, Al. Sb., has a freezing point of 1050°, or no less than 425° higher than that of aluminium. This aluminium-antimony alloy behaves like many true chemical compounds, Stibnite (Sb_2 S_3), for instance, the melting point of which is about 530°, though its constituents, sulphur and antimony, melt at 115° and 335° respectively.

In the case of most alloys, as the mass of the melted alloy cools down, groups of alloys, which are atomically definite in composition, appear to fall out of solution, just as in a cooling mass of granite, atomically definite groups of minerals fall out, the mica and the feldspar, tourmaline, or whatever the grouping may be, but the fluid mass which remains need not be, and probably is not, definite in composition. The silver-copper series presents an excellent case in point, and so do the alloys of lead and tin, and it is satisfactory that this autographic method of recording the cooling of a mass of

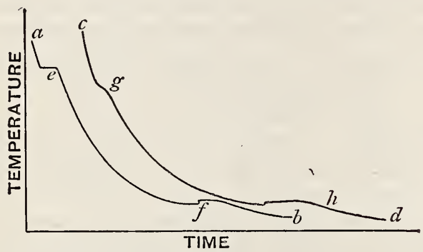

FIG. 10.

alloyed metal enables the whole history of the case to be accurately traced. Turn, for instance, to the tin-copper series which comprise, industrially, a most important group of alloys. Alfred Riche* determined some of their melting points twenty years ago by the aid of a thermo-couple, which makes the hesitation of experimenters to employing thermo-couples in such investigations the more remarkable, and, I may add, my own tardiness inexcusable. He considered that Su Cu_3 and Su Cu_4 alone possess respectively a single definite freezing point. Mr. A. Stansfield working in the author's laboratory, finds that all the tin-copper alloys appear to have two solidifying points, while some appear to have three.

The bismuth-copper series, yield very interesting and unexpected information when examined by this method † It appears that, however small the amount of bismuth alloyed with copper may be, a certain proportion of the bismuth always remains free and does not unite with the copper at all. The cooling curve of any copper-bismuth alloy will, therefore, show at least two freezing points, the lower of which always closely corresponds with the freezing point of bismuth. The general nature of these curves is shown in Fig. 10, in which A, B, is a cooling curve of molten copper, containing about ten per cent. of bismuth, while C, D, represents copper containing 30 per cent. of bismuth. It will be seen that there are two solidifying points in each, at E, F, and G, H, respectively, the points F, and H, being at the same temperature (268°), and are due to the solidification of the free bismuth.

One other curious property of metals may be well studied by the aid of this method of obtaining autographic cooling curves. It is well known that certain metals will, if slowly cooled, pass below their freezing point without actually becoming solid, and that when solidification does occur, the liberation of the latent heat of fusion, in some cases, re-heats the

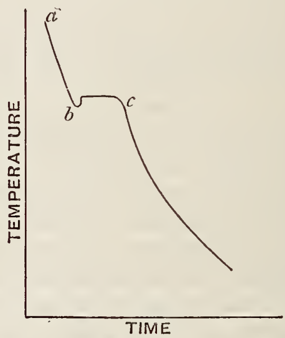

FIG. 11.

mass to the melting point, and causes it to glow vividly even though it had previously fallen below redness. Pure gold and silver present such a case. It is more difficult to observe in the case of copper, but, with care, the occurrence of "surfusion," as it is called, may readily be detected in an autographic curve. Fig. 11 presents a case in point. It was obtained from a small mass of very pure melted copper, into which a thermo-couple protected by clay, was placed. It will be observed that the curve falls in the ordinary way from A to B, but that at B, there is a depression showing that the temperature fell *below* the actual freezing point, which is marked by the horizontal part of the curve, B, C.

The peculiar behaviour of certain metals which absorb gases and release them during

* "Ann. de Chim. et de Phys.," vol. xxx. (1873), p. 417.
† "Proc. Inst. Mechanical Engineers," 1893, Part ii. p. 102.

cooling, may also be well studied by the aid of the recording pyrometer.

It is now well-known that very complicated changes may occur in the molecules of even solid metals, and the new pyrometric methods enable these changes to be studied with facility. The molecular changes which occur in solid metals are of three kinds—

1st. The grouping of the constituent metals of an alloy may be re-arranged.

2nd. Non-metallic elements present in a metallic mass may change their relation to the metallic atoms; and

3rd. The *atoms* in the *molecule* of a solid metal or alloy may be re-distributed or re-arranged, and this is called *polymerisation*.

These molecular changes are almost always accompanied by the evolution or absorption of heat, and can, therefore, be studied by the aid of thermal measurement.

The photographic records have thrown much light on all these cases of molecular change, but for the purpose of minute investigation, another mode of experimenting may be adopted.

Suppose that the spot of light from the galvanometer (Figs. 6 or 7), with which the thermo-couple is connected, does not fall through a slit on to a sensitised plate, but on to a screen placed at some distance from the galvanometer. This screen may be forty feet long, and may be suitably divided into degrees. The room must, of course, be darkened, so that the spot of light may be readily visible. The screen is fixed, and, therefore, the spot of light will traverse it horizontally, and the freezing of a metallic mass would simply be indicated by a more or less prolonged arrest of the spot of light during the solidification of the metal. Suppose, however, that it is not a question of studying the behaviour of a freezing metal, but of one which, though it may be strongly heated, is still solid. Take, for instance, the case of a piece of steel of somewhat low carburisation which is being slowly cooled. Here the molecular behaviour is very complicated. M. Osmond and myself, and, recently, other experimenters, have studied this behaviour minutely. There will be at least two arrest points, and probably three, as the pieces of steel cool from bright redness. One of these will occur at a temperature which varies slightly, but is somewhere close to 650°C., and is caused by a change in the relations between the carbon and the iron. An ordinary photographic record obtained on a plate (of about the size of this page) would simply show a bend in the curve of about the form and amplitude shown in the sketch (Fig. 12). If, however, it is wished to study this particular change more fully, the following plan may be adopted:—Assume that, in indi-

Fig. 12.

cating temperatures up to a white heat, the path of the spot of light along the screen is some forty feet, then it is easy so to arrange the experiment that the spot of light may be received (at the critical part of its path which it is desired to study) on a second, but smaller screen, say, four feet square, which may be moved upwards at a slow, but uniform rate of, say, an inch a second. The spot of light from the galvanometer may be divided by the images of cross wires, and, as the point of intersection of these wires is clearly visible on the moving screen, its position at any given moment may be recorded, by hand, with a pencil mark. The result is, that the portion of the cooling curve which represents the "recalescence" of iron instead of being a small sinuous line, shown in Fig. 12, becomes a loop four feet across, of the form shown in Fig. 13. The same degree of magnification may be applied at any period during the cooling of the steel, and it

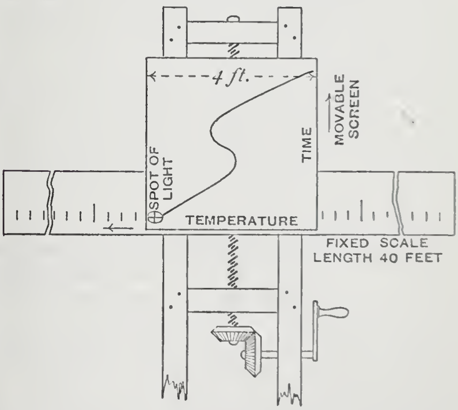

Fig. 13.

enables the molecular change in the iron which occurs at 855°, that is at a higher temperature than recalescence, to be submitted to a very rigorous investigation. For the purposes of lecture demonstration, it is

only necessary to fix a screen of paper on a light frame, and place it like a canvas on an artist's easel, which is provided with a vertical screw for elevating the screen, but it will be evident that for purposes of delicate research some method of uniformly moving the screen could readily be devised.

It is now possible to study the behaviour of alloys at high temperatures and to obtain photographic records of the molecular changes, by the aid of a simple and trustworthy appliance, which is considered to afford "incontestible" results by so distinguished a pioneer in molecular research as M. Raoult.

Miscellaneous.

THE PUBLICATION OF SCIENTIFIC PAPERS.*

By A. B. Basset, M.A., F.R.S.

Two suggestions have been made with regard to the publication of scientific papers—first, that all papers of importance should be published in a central organ; secondly, that a digest containing an abstract of such papers should from time to time be published.

I do not think the first scheme could be carried out so as to cover any useful purpose; for, although it might suit the requirements of a few juvenile societies, it is unlikely that societies of position and standing, which have ample funds at their command for the publication of their proceedings and transacactions, would consent to sink their individuality by giving up the publication of papers communicated to them. Moreover, as many societies derive a considerable portion of their income from the sale of their proceedings, it would be impossible for them to allow the concurrent publication of papers in the central organ, as this might seriously diminish their revenue.

The importance of distributing copies of papers in quarters where they are likely to be read has been alluded to in *Nature* by more than one correspondent. In order to do this effectively, it is necessary that the author should receive a certain number of gratuitous copies. Those are supplied by most scientific societies, and also by many of the American and foreign scientific journals. On the other hand, the *Philosophical Magazine* refuses to present authors with any gratuitous copies, but makes them pay for any that they require. The question, therefore, arises as to whether the proposed "central organ" is going to conduct its business on the principle embodied in the Latin maxim, *Do ut des, do ut facias, facio ut des, facio ut facias*, or whether it intends to follow the example of the *Philosophical Magazine*, and try to get all it can without giving anything in return.

It appears to me most improbable that important and prosperous societies, like the Cambridge Philosophical and the London Mathematical (to say nothing of the Royal), would lend a hand in promoting the scheme of a central organ; and, in that event, the scheme could not possibly be successful, unless it were able to use far greater advantages and attractions to authors than the societies do.

The only feasible scheme seems to be the publication of a digest of papers by the co-operation of the various scientific societies; and, if thought desirable, papers published in foreign countries might also be included. In order to prepare the way for such a digest, I should strongly recommend that, in future, all societies should follow the example of the Incorporated Society for Law Reporting, and require authors to append a head-note to their papers, briefly setting forth the object of the investigation. Every three or four years the titles and head-notes of all papers relating to each separate branch of science should be copied out and arranged in proper order, and a series of digests of each separate branch of science should be published. Mathematicians would thus be enabled to purchase the mathematical digests, and chemists the chemical one. They would thereby be in a position to find out at a glance what papers have been published on their own special subjects during that period. These digests would do for science what the digests of law cases have done for the legal profession. Thirty years' experience has shown that this scheme would work well in practice; and, as many country solicitors take in the "Law Reports," any member of the British Association who desires further information can easily obtain it by applying to one of the leading firms in Nottingham.

To develop an existing periodical, which is a well-known and paying concern, is often more successful than to start an entirely new one; and, as many authors who contribute papers to societies send abstracts of them to *Nature*, it might be worth while considering whether an arrangement could not be made with the proprietors of *Nature* by which a supplemental number could be issued (say, once a quarter) containing a digest of the most important papers published in the United Kingdom during that period. The abstracts (with possibly a little pruning), and also the type used in setting them up, would be available, and the cost of compiling the supplemental number would have to be met by a small extra charge for it.

A committee of members of the British Association might be formed with advantage for discussing this matter, and drawing up a report embodying the recommendations at which they arrive. A copy of the report should then be sent, as soon as practicable

* Paper read at Nottingham before Section A of the British Association, September, 1893.

(without waiting for the meeting next year), to the presidents of the principal scientific societies, in order that it may be laid before their respective governing bodies. Each of the societies which are concerned with free and applied mathematics, and approve of united action, could then appoint a delegate to discuss further proceedings with regard to their own particular subjects, and the same could be done by societies connected with other branches of science.

THE FAUNA AND FLORA OF THE PHILIPPINE ISLANDS.

The fauna of the Philippine Islands is of a very poor character. Consul Stigand, of Manila, says that the *caribao*, or buffalo, is the largest animal in the islands. It appears to have been brought originally from China, though now it is found in a wild state in the interior. It is one of the ugliest of beasts, with a dark, black head, like that of an elephant, and with enormous black horns, bending horizontally backwards. It does a great deal of heavy work, and is patient and under complete control when guided by a native, for foreigners cannot manage it. In its wild state it is dangerous. There are no native fauna of any account. The wild pigs and wild deer, which are abundant, were probably introduced from other islands or from China. There are no lions, tigers, leopards, or beasts of prey of any kind—nothing larger than wild cats and pariah dogs. There is a useful breed of spirited ponies on the islands, which appear to have been brought there by the Spaniards. They thrive well, are very hardy, and work willingly. Monkeys of a small kind abound in the forests; and in Mindoro and other islands there is a diminutive species of deer not much larger than a small terrier, and very graceful in form. Bats are abundant, and there is a large species as big as the flying foxes of India. The poverty of the fauna contrasts strongly with the richness of the same in the neighbouring islands of Java, Borneo, and Sumatra, and even in China, where there are tigers at less than three days' sail from Manila, and the great lack of the larger species of mammalia may probably be accounted for by the great depth of the sea, which began to surround the island before the period of the advent of mammalia, caused by the intensity of volcanic action, which excavated the beds of the neighbouring seas, and so prevented the migration of the larger beasts from the Asiatic continent, while the shallowness of the seas surrounding the western islands renders it probable that these formerly formed part of the Asiatic continent. A few cattle of European breed are annually imported into the islands. Some have lately been imported from Queensland, and sheep are imported from Hong-Kong, but neither cattle nor sheep thrive in the Philippine Islands. The meat of both cattle and sheep is generally very flavourless, which may be in part accounted for by the inability to keep it any time for more than one day after it is killed. Birds, too, are very poor in variety of species. Rare birds of paradise, and other bright-plumaged birds, are found in remote forests, and snipe and wild duck abound in some places. There is a total absence of singing birds. Fish of an edible sort are poorly represented. There is an abundance of sharks along the coasts and in the bays, but there are few good fish for the table, and of all the fish caught in the sea, prawns are the most palatable. There are various descriptions of reptiles and insects, and large numbers of crocodiles are found in most of the deep rivers and uncultivated tracks. Enormous lizards, iguanas, frogs, snakes, crabs, centipedes, tarantulas, huge spiders, ants, cockroaches, mosquitoes, beetles, &c., abound everywhere. In the dry weather the trees around Manila are quite illuminated with fireflies. There are huge pythons in the interior of the forests, and various poisonous snakes in the fields and woods, some of which have a deadly bite. Although a harmless species, the ratsnake frequently takes up his lodging under the roof, and only makes his presence known by the cries of the rats that it seizes. As regards the flora of the islands, there is a great absence of flowering plants, and those which do flower have, as a rule, very small blossoms, and the absence of odorous flowers is as remarkable as the absence of singing birds. Flowering orchids are abundant both in variety and numbers in the forests, but in the towns, a fair-sized plant of an ordinary species cannot be procured under about 3s. By the roadside, near Manila, the principal trees to be seen are the tall and graceful betel-nut palm, bamboo, bananas, and other tropical trees and plants. Vegetables—beans and peas, for example—are grown by covering them up and protecting them from the sun by trellis work, covered with banana and other leaves, but most of the vegetables are brought from Hong-Kong. There is hardly any edible fruit, but mangoes and pine-apples, the latter growing as commonly as weeds. The sugar-cane, coffee-plant, abaca or hemp, tobacco, maize, and rice, are the plants chiefly cultivated. As for the woods of the country, their nomenclature forms an immense list, and the better kinds of wood are, says Consul Stigand, too little known. Some of the woods are excellently suited for furniture, especially the "narra" wood, which has the appearance of mahogany, but is not so close in grain, while having a lighter colour.

MOOLTAN AND PESHAWAR ART POTTERY.

It appears from a monograph on pottery and glass manufacture in the Punjab which has been prepared under the authority of the Indian Government, that a trade in art pottery exists only in Mooltan and Peshawar. Attempts have been made to introduce this pottery into Amritsar by inducing workmen from Mooltan and Sind to settle there, but they have

failed. The introduction of a sort of porcelain manufacture into Delhi has, however, been more successful, and Delhi is now noted for its white pottery. Vessels are occasionally glazed and coloured elsewhere than at Mooltan and Peshawar, but there is no regular manufacture as in those towns. A few potters are still able to make first-class painted and glazed tiles, but the manufacture of tiles, which was once so extensive, has practically died out in the Punjab, and it is stated that even when tiles required for mosques and buildings can be prepared locally, the orders for them are not given to the local workmen. The obstacles in the way of art pottery are the lack of enterprise displayed by the workmen, the jealousy with which they guard their secrets in order to prevent competition, and the readiness they display to abandon old forms and methods suited to native work in order to adopt cheaper and less effective materials such as dies or English patterns that are unsuitable. The Mooltan art pottery is known as "kashigari," the makers are called "kashigars," and are a distinct class by themselves. The Mooltan work is said to have had the same origin as the Sind, but differs from it technically. Originally it was confined to the manufacture of tiles, slabs, &c., painted with text and other designs, and intended to be built into mosques, tombs, and other buildings. The native demand however for this kind of work has died out, and a European demand has arisen which has entirely changed the character of the articles made. The "kashigar" does not himself make the goods he decorates. He buys from ordinary potters, unbaked vessels made of good clay, well prepared, and then smoothes the surface, and fills in all cracks and holes with sand. As the clay is white, there is no necessity to coat the ware with chalk and gum, as is done in Peshawar and in Sind, and a coating of glaze, made of carbonate of lead and gum, mixed in water, is applied to the vessel, and flowers and designs are traced upon this. The groundwork and designs are then coloured, light and dark blue and green being the colours most commonly used. The blue is obtained by applying "lajward" (*lapis lazuli*) mixed with water, the mixture being thick for dark blue, and thin for light. Green is obtained from copper filings. The "lajward" and copper oxide assume the required colours on baking, and after their application the pottery is covered with a glaze and dried, and then baked in a kiln, care being taken to arrange the pottery so that the glaze shall not be damaged. A colour of recent introduction is brown, and for this the pottery requires two bakings. There is one baking before the glaze is applied, and one for the glaze, which consists of oxide of lead, amalgam of tin and mercury and lead. The colours used can only be applied together within certain limits. Thus, on a white ground, designs can be brought out in light or dark blue or green; white designs on a blue ground can be obtained by painting with "lajward" all except the part to be left white; and dark blue on light blue, or *vice-versâ*, is obtained by applying "lajward" more thickly on the designs or on the rest of the pottery. On a brown ground designs in purple are obtained by using "anjani" (an oxide of manganese), and designs in green by mixing copper oxide with the "anjani." The brown colour cannot be produced on a ground of another colour. The demand for Mooltan art pottery is entirely European, and the goods are all exported. The demand, however, is falling off, and the work is deteriorating in quality, as the newly introduced browns and greens are not so effective as the original blues, and deprive the work of its distinctive characteristics. European patterns are also being copied, and a great deal of the ware made is too rough to bear a close inspection, and loses its effect by attempts at minute execution. The makers are very jealous of their secrets, and keep the trade in their own hands. Their industry, therefore, is not likely to spread. The manufacture of glazed pottery in Peshawar for the native table is of ancient date, and may be considered peculiar to the district, for although European pottery is finding its way into Mohammedan households, in many parts of India there is nowhere else a local manufacture of glazed ware for vessels used for eating and drinking purposes. Ordinary clay vessels are used, as in Mooltan, but in Peshawar the pottery is covered with a "slip" or coating of chalk and gum in order to avoid the red colour to which the clay naturally burns. Red is obtained on this white ground by applying a soft red chalk, and black from a soft black stone, both obtained from the Khyber hills. Blue is got from "lajward," and green by mixing copper dust with the glaze. The basis of the glaze used is lead, and the vessels are carefully burned in a kiln fired with wood. Peshawar pottery is noted for its colouring rather than for its form or design. When properly applied, the copper greens and rich mineral colours combined with the thick clear glaze, produce a distinct effect which, though characteristic, might be considered rather *bizarre* than beautiful. There is a great tendency to subordinate form to relief ornamentation, and that of an inferior and debased kind copied from cheap European ware. Very few of the tiles now made are said to be free from grave faults, but some blue and white made about twenty years ago, and used in the ornamentation of a building in the city, show what good work could be turned out in Peshawar under proper guidance. It is impossible to give any idea of the amount of art pottery actually sold in Peshawar, but as great care is said to be taken in other cities in India in weeding out bad styles, this has caused a falling off in the demand for Peshawar ware. The articles chiefly made in Peshawar are pierced dessert plates, brackets, vases, &c., and their prices vary from two to five annas each. The prices average from 20 to 25 per cent. on these prices, and workmen get their food and from six to eight annas per diem.

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Proceedings of the Society.

CANTOR LECTURES.

ALLOYS.

By Prof. W. Chandler Roberts-Austen, C.B., F.R.S.

*Lecture III.**—*Delivered March* 20, 1893.

In the last two lectures certain methods of investigating molecular change in alloys have been studied. It will now be well to direct attention to some of the effects of molecular movement in liquid, and even in solid metals and alloys. That the atoms of gases are in rapid movement may be readily demonstrated by any of the familiar experiments by which the diffusion of a light gas—such as hydrogen—through a porous vessel of clay, increases the pressure in the interior of the vessel. It is less easy to demonstrate the molecular movement in metals, but it may nevertheless be done, as will be shown in the course of this lecture.

It has long been known that the vapour-pressure of a liquid is decreased by the presence of salts in it, and Tammann has shown that the molecular diminution of vapour pressure of any one solvent is nearly equal in value when caused by similar salts. For details as to the elaborate investigations which have been made, the student must refer to such a work as that by Prof. Ostwald on "Solutions;" allusion can only be made here to a law of Raoult, which states that "the lowering of vapour pressures of solutions in different solvents is equal, when the proportion of the number of molecules of the dissolved substances to the number of molecules of the solvent is the same." Ramsay has shown that this law of vapour pressure applies to metals. He dissolved metals in mercury. Two U tubes were used, each with one short closed limb and one open limb; one tube was filled with the amalgam to be examined, and the other with pure mercury. The two tubes were placed side by side in a bath of mercury vapour, and the difference between the heights of the columns was read off. In every case a diminution of vapour pressure was observed, and there was also evidence that the metals tend to form the simplest possible molecules, that is, molecules consisting of single atoms. The numbers found for the molecular weights of calcium and barium are very noteworthy, as they are about half as large as the atomic weights; the number found for potassium is also much smaller than the atomic weight. Aluminium and antimony show a tendency to form complex molecules, and this fact may be connected with the peculiar behaviour already alluded to of antimony and aluminium in forming alloys with each other and with other metals, which bear strong resemblance to chemical compounds.

It may be well to add a brief but somewhat rough explanation as to the diminution of the vapour pressure of a solvent caused by the presence of a dissolved substance.

Take the case of a column of water partly filling a closed glass tube; molecules of water will fly off from its upper surface into the space above and will continue in movement. Some molecules hit each other, some rebound from the sides of the glass tube, while others return to the liquid itself. It will be evident that this molecular movement produces a certain definite pressure, and a state of equilibrium is established when an equal number of molecules leave and return to the liquid in a given time. If a salt is dissolved in the water, there is no longer a free surface of pure water from which molecules are evaporating, that is leaving the fluid, in virtue of their own molecular movement, but the surface is that of a saline solution and not that of a pure solvent, and there will be fewer molecules of water able to escape in a given time, as part of the area of the liquid surface is occupied by salt. There is the same opportunity as before for the bombardment of molecules and for their return to the liquid, but there is less opportunity for liquids to leave the solution, consequently when equilibrium is established, it will be found that the pressure exerted will be *lower* than before, provided the temperature has remained the same. It will be obvious that the same argument applies to the passage of molecules from a surface of pure mercury compared with

* This lecture was an experimental one, and is here given in a somewhat abbreviated form.

mercury containing dissolved metals; the molecules of the metal which is held in solution retarding the evaporation of the mercury, as the salt did that of the water.

It follows that the observed diminution in pressure of a solvent, produced by a given proportion of an added element, should enable the molecular weight of an added element to be calculated, because, by the law of Avogadro, the number of molecules in a given volume of all gases is the same under equal conditions as to temperature and pressure; and, further, experiments prove that the small quantity of metallic impurity present in mercury is in a state similar to that of a gas. It follows that having ascertained the diminution of pressure produced by any given element, the molecular weight of which is accepted, it is easy to deduce the molecular weights of other added elements by observing the diminution of pressure they produce.

The view that the mode of existence of an impurity in a solvent is similar to that of gas, leads to the consideration of the manifestation of pressure exerted within liquids, whether they be saline or metallic, and to this the name "osmotic pressure" has been given. In attempting to explain this, it is necessary to turn to the effect produced by ordinary saline solutions. Let the porous cell, *a* (Fig. 1), which

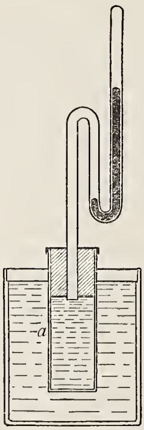

Fig. 1.

has a semi-porous "membrane" of ferrocyanide of copper deposited in its walls, be filled with a solution containing one per cent. of nitrate of potash. The whole cell is then immersed in water, a certain small quantity of which finds its way into the cell, and it will be found that the mercury in the manometer tube will rise thereby, indicating the existence of a pressure of more than three atmospheres within the cell. Pfeffer's* work is the most important in this direction, and to it the student should refer. Now, as Ostwald has pointed out, it was not until van 't Hoff began to develop a theory of solutions on the basis of such phenomena that clear conceptions of the nature of the forces at work were formed, but in his hands the theory has proved to be very fruitful. First, it has been established that osmotic pressure is independent of the nature of the membrane. The amount of water which enters the cell is very small, and need not appreciably dilute the solution of nitrate of potash; water can, moreover, freely pass in or out of the cell. The osmotic pressure must, therefore, be a specific property of the substance in solution, and in this respect osmotic pressure resembles gaseous pressure.† It is not the place to demonstrate this, but let it be accepted that the molecules of the dissolved body do exert pressure; let us, therefore, examine what is the effect of molecular pressure exerted by a small quantity of one metal dissolved in a mass of a metallic solvent.

The presence of a salt in solution raises the boiling point of the solution, because in order to enable an equal number of molecules to fly off in a given time from the surface of a *saline* liquid as from a pure liquid (see *ante*), the temperature must be higher, for, as in the previous case of the depression of the vapour tension by the presence of impurity, there are fewer molecules capable of escaping from the surface of the solvent than there would be if the solvent were pure, and in order to produce sufficient molecular pressure, a higher temperature is necessary. Why then should the freezing point of the solution be depressed by the presence of impurity? The freezing point is influenced by external pressure, but is mainly dependent upon internal pressure within the liquid mass. Arrhenius has shown that in a very dilute solution of a salt, the salt is probably dissociated, its ions are free. It can be imagined that in a dilute metallic solution, say of lead in gold, the lead molecules are also free, and the lead molecules, behaving as gaseous molecules, exert very considerable pressure. It has been shown by Pfeffer's experiments, already referred to, that in the relations between a solvent and the dissolved substance very considerable pressure is exerted. Take the case of melted gold con-

* 'Osmotische Untersuchungen," Leipzig, 1887.

† Van 't Hoff, "Phil. Mag," vol. xxvi., 1888, p. 81.

taining lead as an impurity. As the mass of gold containing lead is about to solidify, its molecules are striving, so to speak, to come into closer contact, but are prevented by the movement of the molecules of the lead, and before the molecules of the lead can be expelled from the gold ones, these latter must do work. The only energy available is that liberated when the gold changes its state from liquid to solid, and a portion of the latent heat of fusion is employed in doing this work of expelling the lead. The gold, on account of the internal pressure due to the lead molecules, exists as a fluid, at a lower temperature than it otherwise would; and, finally, when the gold molecules are ready to come to rest as a solid, they cannot possess the same kinetic energy as they would if the intruding lead molecules had not been present, because they have done work on the lead. The freezing point of the gold is thus lowered, and the energy for the expulsion of the lead molecules has been drawn from the latent heat of fusion.

In the case of a metallic mass with a small quantity of impurity, the action appears to be as follows. Suppose the metallic mass to be gold, and the impurity platinum. The mass cools and begins to freeze, pure gold separates (the analogue of colourless ice which would separate from a dilute solution of a coloured salt), and the dissolved platinum is forced to occupy a smaller space. In order to effect this concentration, work has to be done by the freezing metal, part of the latent heat liberated by freezing is employed on the work of concentrating the platinum. The metal gold can however, fall below its normal freezing point without becoming solid, if sufficient internal pressure is available to keep it fluid, and this pressure is supplied by the osmotic pressure caused by the movement of the particles of platinum.

The main interest connected with osmotic pressure exerted in alloys is derived from the fact that the presence of a metallic impurity in a mass of a metallic sclvent lowers the melting point. It may incidentally be observed that the curves of cooling obtained by the autographic recorder already described are of much interest in this connection, as they afford a measure of the heat liberated on solidification of a pure or impure mass of metal. Thus if the continuous line in Fig. 2 represents the cooling-curve of very pure gold, and the dotted line that of gold contaminated with lead, then the shaded area will afford a measure of the heat expended in overcoming the osmotic pressure due to the added lead.

I have extended the work of Heycock and Neville to a solvent with a much higher melting point than they used, and have em-

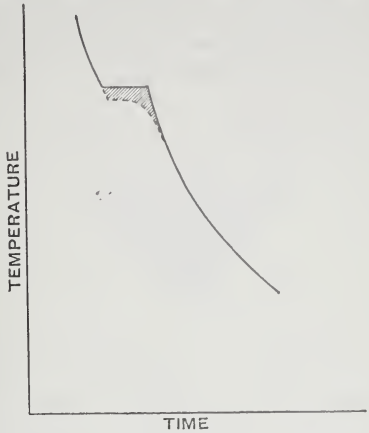

FIG. 2.

ployed gold as the solvent, the measurements of temperature being made with a platinum-rhodium thermo-couple, as has already been described.

It will be obvious that it is of a very important advance to have enabled the changes which occur during the cooling of a mass of metal, with so high a melting-point as gold, to be recorded automatically.

In my last course of Cantor lectures a description was given of certain attempts to separate the constituent metals of alloys by electrolysis. It was shown in some experiments made by myself, that the action of a current of 300 ampères on an alloy of gold in lead, or of silver in lead, entirely failed to reveal the existence of the slightest separation of either of the metals from the lead. Other attempts have since been made by more than one experimenter, but, so far as I am aware, entirely without success. I also attempted to separate aluminium alloyed with gold, in a series of alloys which have since proved to be of a remarkable character; but hitherto the results of the electrolytic experiments have been absolutely negative. Before leaving the experiments connected with the passage of an electric current through an alloy, the following very interesting experiments of E. Warburg and F. Tegetmeier*

* Wiedemann's "Annalen," vol. xli. 1890, pp. 1–41. E. Warburg, "Galvanische Polarization." F. Tegetmeier, "Ueber die electrolytische Leitung des Glases und Bergkrystalls." Also "Revue Générale des Sciences,' 1892, p. 515.

deserve more than a passing notice. Their experiments would seem to demonstrate the possibility of producing eventually a degree of porosity in vitreous bodies, which will admit the passage of elements having comparatively small atomic volumes, while other elements having larger atomic volumes are strained off, thus occasioning a mechanical sifting of the elements. A receptacle, Fig. 3, was divided

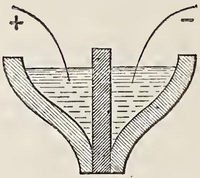

FIG. 3.

by a sheet of glass, which could be several millimetres thick. Sodium amalgam was placed on one side, and pure mercury on the other; the whole was then heated to the moderate temperature of 200° C., at which the glass becomes slightly conducting. By the aid of a Planté battery, the sodium atoms of the sodium silicate present were set in motion, and after the experiment had continued thirty hours, it was found that a considerable quantity of sodium, amounting to 0·05 gramme, had passed into the mercury, which was originally pure. A corresponding amount of sodium had been lost by the amalgam; but the glass had exactly preserved its original weight and clearness. The glass was partly composed of neutral molecules of sodium silicate, together with free molecules both of sodium (base) and of the acid, and the free sodium was capable of being transported under the influence of the electrical current. When, however, Tegetmeier replaced the sodium amalgam by lithium amalgam and repeated the experiment, the sodium of the glass passed as before into the originally pure mercury, and the glass became opaque on the side touching the lithium amalgam; but after a time the opacity extended right through the thickness of the glass, and then metallic lithium began to accumulate in the previously pure mercury. It is not possible thus to chase out all the sodium present in the glass; but the *free* sodium atoms are replaced by those of lithium. Analysis showed that the glass originally contained 2·4 per cent. of potassium and 13·1 per cent. of sodium; but after the experiment, while retaining the same per-centage of potassium, it had 4·3 per cent. of lithium and only 5·3 per cent. of sodium. The glass in which lithium has thus replaced part of the sodium is very tender, and is opaque and friable. The conclusion is that the atoms of lithium, having an atomic weight of 7 and an atomic volume of 15·98, can pass along the tracks or molecular galleries left in the glass by the sodium atoms, the atomic weight and volume of which are 23 and 16·04 respectively. When a metal of superior atomic weight and volume to sodium is substituted for the lithium—such as potassium with atomic weight 39 and atomic volume 24, it is found not possible to chase out the sodium, the new atoms being too big to pass along through the spaces where the sodium had been. We are thus confronted with a molecular porosity which can, in a sense, be gauged; and the mechanical influence of the volume of the atom is thus made evident.

In this connection an almost forgotten experiment of Homberg's*, and a singular extension of it by Guthrie, becomes of much significance. I have elsewhere directed attention to the fact that so long ago as 1713 the Dutch chemist, Homberg, wrote a remarkable paper "On substances which penetrate and which pass through metals without their being melted," in which he points to the singular rapidity with which mercury will pass through zinc. He shows that a bar of zinc, one inch wide and half inch thick, will be penetrated by mercury in thirty seconds so that it breaks readily, although before the addition of the mercury the bar would bend double without any sign of fracture. Guthrie†, who does not appear to have been aware of Homberg's experiment, placed an amalgam of potassium and mercury, containing 1·34 per cent. of potassium, in a hollow cylinder of cast zinc, the walls of which were two millimetres thick, and the thickness of the bottom ten millimetres. The amalgam was scraped upon the zinc so as to ensure contact, and then covered with petroleum. The zinc cylinder was corked up and covered with paraffin. It was placed in a beaker of distilled water, and, after two months standing, no potassium found its way through the zinc. Neither could mercury be detected in portions of zinc taken from the outside of the cylinder, though if the mercury had not contained potassium the zinc would have been completely disintegrated or as it were

* "Mem. de l'Acad. Royale des Sciences," 1713 (vol. for 1739, p. 306).

† "Phil. Mag.," vol. xvi., 1883, p. 321.

"slaked" by mercury. Not only, therefore, did the potassium fail to follow the mercury into the zinc, but it prevented the mercury from entering the zinc at all. These experiments are of great interest and must be continued, with a view to ascertain the influence of the atomic volume of the metal added to mercury in preventing its penetration of zinc and other metals. It must be remembered that in the case of gold, sodium amalgam "wets" the precious metal more readily than pure mercury does.

In the last course of Cantor lectures on "Alloys," I described the experiments which led me to the view that the effect of impurities added to gold is nearly proportional to their atomic volumes, the larger the volume of the atom the greater being its effect. The results attracted much attention, and the Institution of Mechanical Engineers appointed a strong committee in order to ascertain whether the action of impurities on masses of metal is in accordance with the periodic law of Mendeléeff. Two Reports have already been presented by this committee, from which it appears that while the law does apply to iron, it is only partially true in the case of copper.*

A fact of considerable industrial importance was established in connection with the use of copper for fire-boxes for steam boilers, as it was shown that the presence of a small quantity of arsenic is positively beneficial, and not harmful, as it has hitherto been supposed to be.

Many points of interest in connection with the constitution of alloys were developed in the course of these Reports, and one relating to the effect of pressure on the molecular change in fusible metal may be mentioned here.

It has long been known† that when a triple alloy of bismuth, lead, and tin, which bears Newton's name, is cooled down from the molten state, there occurs, long after the metallic mass has solidified, a remarkable rise in its temperature. Experiments made in view of the Report show conclusively that this evolution of heat occurs generally at 46° C. An evolution of heat also takes place if the solid mass is cooled rapidly by quenching in water. This effect, however, disappears after the third or fourth heating, but may be restored by remelting the mass, or by raising it to a temperature just below its melting point. A suitable alloy for the experiment is the one containing 50 per cent. bismuth, 31¼ per cent. lead, and 18¾ per cent. tin. The appearance of the fractured surface of the mass, if broken before the evolution of heat, is plate-like, crystalline, and almost vitreous; but after the thermal change the fracture is grey, dull, and finely grained. It will be evident that the changes this alloy undergoes present certain analogies to those which take place in steel during the "hardening" by rapid cooling from a high temperature, and when the metal cools slowly from bright redness. In the latter case, if low-carbon steel be the subject of the experiment, there are at least two distinct evolutions of heat, one at 855° C., due, it is believed, to a molecular change in the iron, and the other at 655° C., arising from a change in the relation between the carbon and the iron. Newton's alloy, now under consideration, contains three constituents; and the alteration which is made evident by evolution of heat must clearly be due either to a change in the mutual relations of the constituent metals, or else to polymerization or redistribution of the atoms in the molecules of the solid mass, either of which change is attended with the evolution of heat. That molecular modification does take place in these alloys during cooling has been shown by E. Wiedemann* and by Spring.† In steel, carbon is present, and complicates the problem under examination, which is not the case with Newton's alloy; but in the latter it is possible that one or other of its three constituent metals may play a part analogous to that of carbon.

A careful study was therefore made of the behaviour of the alloy, and it may be well to publish the results in full at some future time; at present it is only necessary to summarise the conclusions to which the investigation appears to lead. The question arises, Is the quenched Newton's metal the analogue of hardened steel? First, as regards change of volume; Ermann, and afterwards Kopp, found that the expansion of similar alloys is abnormal. The present experiments show that the change from the vitreous variety of the alloy to the finely crystalline one is accompanied by an expansion in its volume of about 0·8 per cent. Steel also expands during the operation of hardening. The tenacity of the alloy in the vitreous state is very low, only about 1 ton per square inch; but after the molecular change a maximum of

* "Proc. Inst. Mech. Engineers," 1891, p. 543; and 1893, p. 102.

† Ditte, "Leçons sur les Métaux," 1891, part i., p. 21.

* Wiedemann's "Annalen," vol. iii., 1878, p. 237.

† "Bulletin de l'Académie Royale de Belgique," vol. ii., 1886.

$2\frac{1}{4}$ tons per square inch is attained, the effect being the same whether the change has taken place spontaneously, or has been induced by rapidly cooling the alloy. Annealing the bars at a temperature of 80° to 90° C., after the molecular change has taken place, appears slightly to increase their strength. The alloy solidifies at or about the temperature of 96° C, with a range of pastiness extending over several degrees, which prevents any mechanical measurements from being made until the mass has cooled to about 92° C. Throughout the range of temperature between 92° and 80° C., it contracts at an average rate of 0·000144 of its length per degree Centigrade; and the contraction continues, but in gradually decreasing amount, until at 49° C. it ceases, and the metal commences to expand. The amount of the expansion is considerable, nearly one per cent. of its linear dimensions, and appears to be due to some process resembling that of combination, for it requires an appreciable amount of time for its complete development, and is accompanied by a considerable evolution of heat. If, on the other hand, the alloy be cooled too slowly, the evolution of heat is not well marked. The converse phenomena of contraction with absorption of heat, noticed upon reheating the alloy, does not occur at the expected temperature, but at a higher one; and the fact that the change is not truly reversible, supports the view that the molecular change in the alloy is due, as is doubtless the case in steel, to combination on cooling, and to dissociation on heating occurring in the solid mass.

Under these circumstances it became interesting to see whether the application of pressure would cause the change to take place at a lower temperature than that at which it would occur without pressure. A steel die was formed with a surrounding water-jacket (Fig. 4). The plug of the die had a steel socket, in which the thermo-junction was inserted, so that the pressure did not come upon it in any way. This was found to be necessary, as otherwise the insulation failed, and the metal was "squirted" along the wires, causing a short circuit. The alloy, N, was poured into the cavity of the die, which had previously been lined with several folds of paper; the die was closed and placed in the press, and then heated until the metal again became fluid. A steady stream of cold water was then run through the water-jacket, and, by the thermo-junction, inserted in the socket before mentioned, an autographic record of the temperature was taken, whilst pressure was steadily applied to the die. It had previously been found that the abnormal rise in temperature in the absence of pressure was coincident with the expansion of mass. The result of the experiment showed that, under a pressure of one ton per square inch, the temperature at which the thermal change took place was lowered as

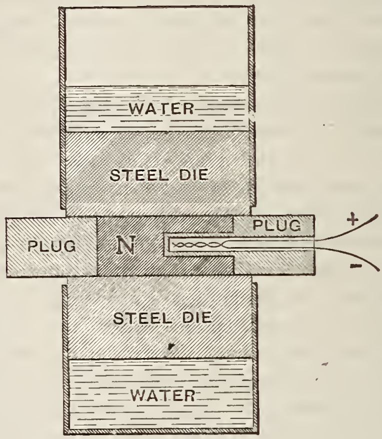

FIG. 4.

much as 4° C., and that a pressure of about four tons per square inch was sufficient to obliterate the thermal disturbance altogether. It is interesting, therefore, to see that, where the pressure is sufficient to cause the particles of the mass to assume the quasi-fluid state, the changes are greatly modified.

The effect of pressure in lowering the critical point in this alloy is evident; and it was interesting thus to ascertain whether the compression of the mass had really prevented the alloy from undergoing the molecular change from the vitreous to the grey variety; or whether the "recalescence" had been so gradual, that there was no sudden augmentation of temperature in the cooling mass, such as would be indicated by a marked discontinuity in the autographic curve. The die was accordingly made in halves, so that it could be rapidly opened when the pressure was released. The solid cylinder of compressed alloy was removed and fractured with as little delay as possible; but it was found that the change, though not complete, was far advanced. It is impossible to say whether the change occurs directly the pressure is removed, or during the time it has been applied.

The profound change which is produced in the properties of metals by alloying them is well shown by some recent experiments by

Professors Dewar and Fleming.* The diagrams Figs. 5 and 6 will serve to make clear the nature of their remarkable results. They have examined the effect of very low temperatures on the electrical resistance of pure metals and alloys; and the results tend to prove that, if

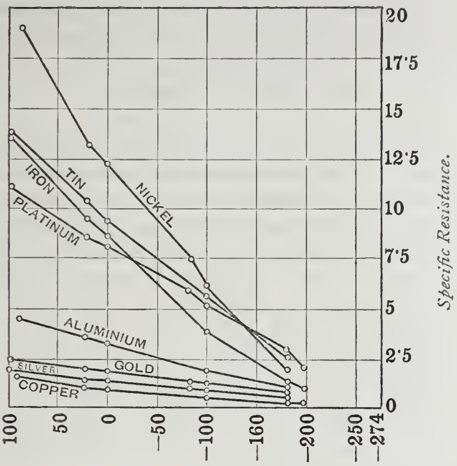

FIG. 5.

pure metals could be reduced to the absolute zero of temperature, they would offer no resistance to the passage of an electric current. This is true of soft pliable metals like gold, and rigid ones such as nickel. Impure metals and alloys behave very differently; the diminution

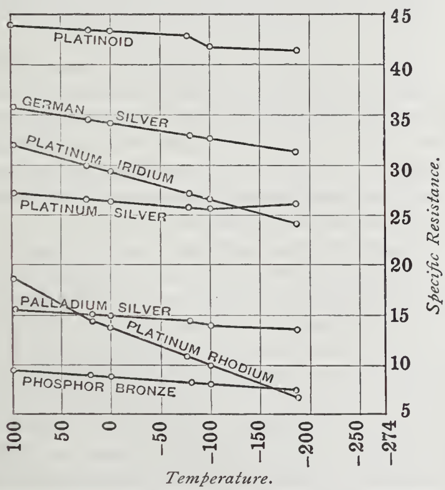

FIG. 6.

of resistance by exposure to cold is very marked, but the direction of the curves representing resistance and temperature appears to indicate that the resistance at the absolute zero of temperature would still be considerable.

Mr. Laurie has continued his researches by which he determined the electromotive force of alloys, with a view to obtaining indications as to their molecular grouping. His work on the tin-copper series was referred to in the last course. He now shows that if the method he previously adopted be applied to the alloys formed from zinc, tin, lead, and cadmium, which are grouped together by Matthiessen as forming mixtures only with each other, the electromotive force rises at once on introducing only a small quantity (about 1 per cent.) of the more pristine metal, thus confirming Matthiessen's view. The method has also been applied to the tin-gold alloys with the following results. Matthiessen found, on plotting the conductivities of these alloys, that the resulting curve resembled a W, having one maximum point, and two minimum. He therefore suggested that probably three chemical compounds existed, corresponding to the three points. The electromotive-force method, however, does not altogether confirm this view. One compound is shown to exist corresponding exactly with the maximum point of the curve. Mr. Laurie has suggested that probably this result gives the correct interpretation of Matthiessen's curve, and that only one compound exists. The compound may, from its behaviour, be regarded as if it were the dip of the curve on each side corresponding to the curves obtained by Matthiessen for other metals where no compound exists, but where a small trace of one metal profoundly alters the properties of the other metals with which it is mixed.

The analogy of alloys to natural silicates has been pointed out by Mr. H. M. Howe, who also shows that the action of impurities on alloys resembles that of foreign matter in silicates; for, as he says, the presence of one or two per cent. of soda would at once alter the fusibility of any silicate.

Mendeléeff* also shows that the crystallization of igneous rocks is similar to the behaviour of certain metals forming a homogenous alloy from which definite crystalline compounds separate as the mass cools. As evidence that certain alloys have a constitution which resembles salts, he says that an alloy of sodium and zinc is, in a wide sense, a salt in many of its reactions, for it is subject to the same double decompositions as sodium phosphide or sulphide which clearly have saline properties. The latter, when heated with ethyl-

* "Phil. Mag.," vol. xxxiv. 1892, p. 327; vol. xxxvi. 1893, p. 271.

* "Principles of Chemistry," vol. ii., p. 112, note 21.

iodide forms ethyl-phosphide, and the alloy of zinc and sodium gives zinc ethyl; that is, the element (P, S, Zn.) which was united with the sodium passes into combination with the ethyl—

$$RNa + Et\ I = REt + Na\ I.$$

hence, the alloy of zinc and sodium is a saline substance in the same sense that sodium sulphide is.

The following circumstances may also be observed:—With chlorine, sodium gives one compound; with oxygen, at the most three; with sulphur, five; with phosphorus, probably still more; with antimony, naturally, still more; the more analagous an element is to sodium, the more varied are the proportions in which it is able to combine with it, the less are the alterations in the properties which take place by this combination, and the nearer does the compound formed approach to the class of compounds known as indefinite chemical compounds. In this sense, a silicious alloy, containing silica and other acids, is a salt. The oxide, to a certain extent, plays the same part as the soda, whilst the silica plays the part of the acid element which was taken successively by zinc, phosphorus, sulphur, &c., in the above examples.

Such a comparison of the silica compounds with alloys presents the great advantage of including under one category the definite and indefinite silica compounds which are so analogous in composition; that is, it brings under one head such crystalline substances as certain minerals, and such amorphous substances as are frequently met with in nature, and used artificially prepared, as glass, slags, enamel, &c.

If the compounds of silica are substances like the metallic alloys, then (1) the chemical union between the oxides of which they are composed must be a feeble one, as it is in all compounds formed between analogous substances. In reality, such feeble agencies as water and carbonic acid are able, although slowly, to act on and destroy the majority of the complex silica compounds in rocks. (2) Their formation, like that of alloys, should not be accompanied by a considerable alteration of volume, and this is actually the case.

Dr. Alder Wright's* experiments on the distribution of a constituent of an alloy between two other constituents considered as solvents, must be consulted in his original papers, which are too elaborate for useful abstraction here.

* "Proc. Roy. Soc. 1889-93."

The same must be said of Colonel Edward Matthey's* very interesting and important papers on the "liquation" of alloys of precious metals. Working with masses of metal worth thousands of pounds, he has done more than any recent experimenter to clear up this curious molecular behaviour of alloys, which is of so much industrial impoitance.

There can be no question that the general interest in alloys deepens daily, and one very gratifying indication of this fact is afforded by the notes on alloys which have from time to time been published in recent volumes of "Industries." The appearance of these notes, which deal more particularly with alloys of industrial importance, renders it the less necessary to do more, in the brief space of these lectures, than pass in review those particular portions of research connected with alloys, which appear to afford the most hope of immediate progress.

Miscellaneous.

GRANTS FOR DRAWING IN EVENING CONTINUATION SCHOOLS.

Annual grants for drawing are made by the Science and Art Department to evening continuation schools in England, Wales, and Scotland, under the rules of the current edition of the Directory (pages 89 and 90), or under certain other conditions, which are published, and managers are free to apply under either set of conditions:—

A grant of 1s., 1s. 6d., or 2s., according as the award to the school is "Fair," "Good," or "Excellent" respectively, is made for each scholar, provided that the managers certify that—(*a*) The scholar has not been examined in drawing under the rules of the Department of Science and Art within the three months preceding his examination in drawing at the evening continuation school; (*b*) the scholar has received at least 20 hours' instruction in drawing in the school year at the evening continuation school; (*c*) the school has met not less than 30 evenings in the school year; and (*d*) that each scholar on whom the drawing grant is claimed has received at least 12 hours' instruction in the school year in each of two other subjects recognised by the Education Department.

* "Phil. Trans." vol. lxxxiii. 1892, p. 629.

The following is the syllabus for drawing issued by the Department :—

Explanatory Note.—The objects of the course of instruction in drawing in evening continuation schools should be both to provide scholars who have not had an opportunity of going through the entire course of drawing in the elementary school with the means of perfecting themselves in the elementary drawing therein provided for, and to assist such scholars or others to carry that instruction forward. A sample syllabus is given below, but managers are not restricted to it. They may propose a syllabus or scheme of their own. Such alternative syllabus or scheme must be submitted to and approved by the Department of Science and Art before being adopted for use.

Drawing Materials, &c.—The materials to be used in drawing may be lead pencil, chalk, and water-colours. The use of water-colours should not be attempted until some mastery in drawing with the pencil and chalk has been acquired. Practice in drawing with compasses, scales, rulers, curves, and such like instruments, should be concurrent with freehand drawing. The drawings may be done either from flat examples or from actual objects and things, and should be done in outline first of all; the representation of effects of light and shade may be practised subsequently.

Course of Instruction.—The course is divided into sections for the convenience of managers, but any part of the course may be proposed.

Section A.—(1) Freehand drawing in outline from flat examples of ornamental forms and objects composed of straight and curved lines* with a pencil or chalk; with a brush or tint of colour. (2) Drawing in outline, with rulers and compasses, enlarged or reduced copies of diagrams of geometrical figures,† and of objects of simple geometrical construction,† such as simple forms of building or machine construction, and learning how to take measurements of such simple objects.

Section B.—(1) Freehand drawing from simple objects; (*a*) having straight lines, such as a salt-box, a ladder; (*b*) having curved lines, such as a flower-pot, a jug with handle; (*c*) having straight and curved lines combined, such as a wheelbarrow, an arched doorway, or single flowers and fruits and large leaves. (2) Drawing in outline with rulers, scales, and compasses (plans, elevations, and sections), from measurements made by the student himself, of actual objects of simple construction, such as a box, a panelled door, three or four steps in a flight of stairs. (3) Drawing in outline with rulers, scales, and compasses from diagrams of machines or parts of machines, more complicated than those in A (2): and practice in the representation of varying tones of shadow, and of different materials in building constructions, by lines, and by tints of colour.

* These might be similar, if the managers desire, to those in Standards IV. and V. of Elementary School Illustrated Syllabus.

† As in Standards IV. and V.

Section C.—(1) Freehand drawing in outline from casts of architectural mouldings, and ornamental forms; or from real fruits, flowers, or plants. (2) Drawing in outline with instruments from measurements (plans, elevations, and sections) of mechanical objects, such as a cog-wheel, a tap, a door-lock, and chain.

Section D.—(1) Freehand drawing in light and shade, with pencil and chalk, from simple objects of domestic use, sprays of foliage, flowers, and fruits, and casts of architectural mouldings, and ornamental forms. (2) Practice in arranging colours, by tinting freehand outline drawings of ornament, with not more than four flat tints of colour. (3) Tinted and shaded drawing with instruments, in inks, tints of colours, &c. (plans, elevations, and sections), from measurements and specifications of objects of simple construction.

Section E.—Freehand drawing in light and shade, with brush and water-colours, from objects as in *D* (1).

AGRICULTURAL RESOURCES OF SALVADOR.

The chief agricultural products of Salvador are coffee, indigo, sugar, balsam, tobacco, indiarubber, mora wood, and rice. The United States Acting-Consul at San Salvador says that coffee grows in all the departments of the Republic, on ground 1,500 feet above the level of the sea. The richest coffee plantations are situated in the departments of Santa Ana, Sonsonate, Ahuachapan, La Libertad, and San Salvador. Cuscatlan comes next after these, and La Paz and Usalutan follow. The preparation of the ground for a coffee plantation is quite simple. It consists merely in the partial clearing of the virgin wood that covers the mountain side, and the digging of holes one foot square, some 15 inches deep, and 6 or 8 feet apart, in which the young trees are transplanted from the nursery. The plant that produces indigo grows principally in the barren rocky soils of the department of Chalatenango, Cabañas, and also those of Santa Ana, San Vincenti, and San Miguel. After the plantation has been prepared, by cutting down and burning the brush and undergrowth, the seed, or *mostaza*, is sown, and allowed to grow as best it can. The crop grows luxuriantly, and ripens rapidly (in September, if sown in May), yielding a first crop, called *tinta nueva*, or new ink, five months after sowing. When the brush reaches its maturity, it is cut a few inches from the foot, tied during the morning in sheaves about 10 inches in diameter, and taken immediately from the field to the *obraje*. This consists of a set of three *pilas*, or tanks made of brick, placed on close proximity to one another, and on different levels. The sheaves are first piled in the uppermost tank to the brim, and the water is allowed to run into it till the highest bundle is covered,

heavy weights being placed on the whole to avoid the falling out of any bundle during the course of future operations. The action of the water and the pressure on the green leaves and stalks of the *figualite* or indigo plant, causes it quickly to enter into a high state of fermentation, and when this reaches a given degree, the outlet of the tank is opened and the water is permitted to run into the second deposit just below the first. Here the greenish liquid resulting from the maceration, or, rather, infusion, already described, is by means of long paddles, or other instruments, beaten in order to oxygenise it, and when this is effected, it is made to flow into the third tank, where a maceration of a shrub, known by the name of *cuaja tinta*, is added. This slowly precipitates the indigo suspended in the liquid to the bottom of the tank, and the clear water of the top is gradually allowed to escape. The *tinta* has at this stage all the appearance of a fine soft mud of a beautiful purple colour. It is next subjected to several processes, in order to get it ready for market in small cakes of very light weight. The fineness of the quality of the indigo depends a great deal more upon the skill and activity of the *puntero*, or manager of the elaboration of the dye, than upon the materials employed. Sugar-cane grows in all the departments of Salvador, and the greater portion of the sugar produced is consumed in the country itself, either in cakes or loaves of white, compact sugar, weighing 25 or 40 lbs., or in small 2 lb. blocks of brown sugar or *panela*, which is also employed in the manufacture of native rum. There are no sugar refineries in Salvador. Balsam is the product of the *Myrospermum Salvatoriensis*, or *Hoitziloxill*, which grows almost exclusively on the "Costa del Bálsamo," or balsam coast of Salvador, comprised by the southern shores of the departments of Sonsonate and La Libertad. The balsam is a beautiful tree averaging a hundred feet in height and twenty inches in diameter. There are two methods of extracting the liquid which has been erroneously called Peruvian balsam. The first consists in scraping the skin of the bark to the depth of one-tenth of an inch with a sharp machete in small spaces some twelve to fifteen inches square all along the trunk and stout branches of the trees. Immediately after this operation, the portions scraped are heated with burning torches made out of the dried branches of a tree called *chimaliote*, and after this pieces of old cotton cloth are spread on the warmed and half charred bark. By punching the edges of the cloths against the tree with the point of the machete, they are made to adhere. In this condition they are left for twenty-four and even forty-eight hours (in January) when the rags are gathered and submitted to a decoction in large iron pots. After this the rags are subjected, while still hot, to great pressure in an Indian machine made of strong ropes and wooden levers worked by hand. The balsam oozes out and falls into a receptacle, where it is allowed to cool. This is called raw balsam. To refine it they boil it again and drain it, after which they pack it in iron cans ready for market. The other method of extracting balsam consists in entirely barking the trunk and heavy branches of the tree, a process which as a rule kills it outright and at best renders it useless for several years. The bark is finely ground, boiled and submitted to pressure in order to extract the oil, which is considered of an inferior quality to that obtained by the system first described. Both methods are defective, but the latter is ruinous, and is forbidden by the authorities. The name of "Peruvian balsam" was given to this article because it was first sent from Salvador to Peru, in the time of the Spaniards, and from Callao re-shipped to England. Salvador produces several varieties of tobacco, which grows in all the departments of the Republic. If it were not for the carelessness of the agriculturists in the drying and final preparations of the leaves, there is no doubt that the very best qualities could be obtained. Farmers allow the leaves of the plant to be dried in the sun when still adhering to the stalk, which they cut about two inches from the ground. After subjecting the plants to the combined action of the sun during the day and the heavy dews of the night until they are dry, they pile them in round blocks some six or ten feet in diameter and three feet high, called *prensas*, on the top of which they place heavy weights and cover the whole with a thick layer of dry banana leaves. Fermentation ensues, the pile becomes quite hot, and the leaves acquire colour and aroma. After several hours the tobacco is aired and the leaves are picked from the stalks, sorted, and tied in bundles averaging one pound in weight, ready for the market. Of all the tobacco produced in the country only one-sixth part is at most exported, the remainder being consumed in cigars and cigarettes by men, women, and children. The indiarubber tree grows wild in the woods that cover the low, marshy plains of the departments of La Paz, Usulutan, San Miguel, and La Union. The methods observed in extracting the gum are similar to those employed in the rest of Central America. Among the other agricultural products of Salvador are rice, Indian corn, wheat, potatoes, and vegetables of a great variety.

SICILIAN SULPHUR INDUSTRY.

From a report which has recently been prepared by the British Vice-Consul at Palermo, it appears that there are 818 sulphur mines on Sicily, 581 of which are worked and 237 closed. The output between 1880 and 1891 may be reckoned at about 4,000,000 Sicilian "cantars" (13 cantars to an English ton); but in 1892 it was almost 5,000,000, thus exceeding by 500,000 the highest quantity produced between 1884 and 1886. The quantity of sulphur ore extracted in 1891 was more than

2,500,000 tons; the mineral obtained therefrom was 347,568 tons, of which 310,272 tons were exported. When compared with the production and exportation of sixty years ago, which was 38,461 tons, it will be seen that the development attained by this industry is very great, yet not to be wondered at when it is remembered that Sicily is really the only sulphur-producing country in the world, the few thousand tons exported by Japan not affecting Sicily in any way. The men finding work in and about the mines in 1891, numbered 32,269. This does not include carters, drivers, and carriers generally, who convey the mineral to the coast from the mines not within touch of the railway, nor does the number include storekeepers, shippers, &c., who are all directly or indirectly engaged in the trade. The total is roughly given at 50,000. The persons working the mines in Sicily are generally termed *esercenti*, and are divided into three classes, namely (1) proprietors, (2) *gabelloti* or leaseholders, and (3) *partilanti* or contractors. Some proprietors work their mines themselves, while others lease them on what are termed *gabelle*, and sometimes the proprietors and the leaseholders have their mines worked by *partilanti*. The *gabella* of a sulphur mine has all the forms of a special contract, whereby the proprietor cedes to the *gabelloto*, at the entire cost and charge of the latter, the working of a mine for a given period under determined conditions, the main one being that the owner shall have, free of all expense, and at his choice, a certain proportion (20 per cent. on an average) known as the *gabella* or rent of the mineral produced. The owner likewise having the option of appointing overseers or inpectors to keep the *gabelloto* within the terms of the contract, to order the suspension of work if deemed expedient, and to direct repairs when necessary, all this in addition to taxes and dues, to be borne by the *gabelloto* or leaseholder. Among other conditions it is usually decreed that the *gabelloto* shall so work the mines as to leave columns of ore supporting arches (also of the ore when the rock alone is not sufficiently firm) and the columns themselves resting on beds or heaps of ore called "pasture"—all this ore reverts to the owner when the *gabella* ceases. It is often further agreed that the *gabelloto* must keep and deliver over mine free of water and earth, must remove the ore by *scale* (stairs), use *calcaroni* (kilns) for smelting and so forth. The object being that the owner should derive the greatest advantage possible, without being put to the slightest expense. The *partilo* is a verbal agreement without a definite limit of time, *i.e.*, it lasts until one of the parties recedes from it or proposes a change. By this verbal agreement the working of a mine or part of a mine, the fusion of the ore, the cost of labour, maintenance, &c., are undertaken by a foreman workman for a fixed compensation in money for every *carico* (264 lbs.) yielded. Whilst the mineral is being extracted sums on account are advanced, and settlement is made on final delivery. The *partilante* often takes pickmen into partnership. The supervision of the works is exercised by the owner or *gabelloto*. The pickmen, assisted by gangs of boys, known as *carusi*, excavate the ore, break up the rock, and heavy pieces of it are carried by the boys to the surface. The men are paid by the *cassa* (a cubic measure) of rock thus carried up. The pumping of the water is always done by the person pairing the lease of the mine and not by the *partilante*. The ore on the surface is collected into a heap preparatory to its fusion. There are five methods of fusing sulphur, but the greater part of the ore at the various mines is still fused by the old method of *calcaroni* or open kilns, owing to the cost of their construction being less than the adoption of other methods, the loss of sulphur caused by the escaping fumes being very great. The *calcaroni* are built of masonry, cylindrical in form, with a sloping floor. They hold from 750 to 1.000 cubic metres of ore—one cubic metre being equivalent to one ton and a half. At the bottom there is a vent hole for running off the molten sulphur into wooden forms. When the *calcarone* is first filled, large pieces of ore are placed at the bottom so that there may be no impediment to the running out, and the work of piling up large heaps between the quadrangular walls goes on, the pieces of ore getting gradually smaller, until the top of the *calcarone* is reached; the ore is then heaped in the form of a cone, and this is covered with calcined refuse, in order to prevent loss and protect it from the elements. In order that the crops may not suffer from the sulphur fumes, the *calcaroni* are only allowed by law to be in operation from June 28 to the end of December, and one fusion of a large *calcarone* lasts three months. The "Gill" system, invented by an Englishman, consists of ovens and masonry, similar in form to the *calcarone*, but much smaller and covered in with a cupola of masonry. They are generally built and worked in couples, and each cell contains from five to thirty cubic metres of ore; they are also built in batteries of four, and the system is this: after being charged, the ore in one cell is set fire to, and the smoke, instead of passing into the open air, as is the case with the *calcarone*, passes into the adjacent cell, and gradually heats the mineral contained therein, until, by the time the first cell has finished working, the other has reached such a temperature that the ore ignites, and No. 1 cell is again filled, and so the process goes on. The advantage is that the gases, which are heavily charged with sulphur, are not lost, and the percentage of sulphur recovered is considerably higher; further, the time occupied is much less than with the *calcaroni*, the working of each cell occupying from 72 to 96 hours, and as very little smoke escapes, the proprietors can work all through the year. Another system of fusing is the "Di Stefano," but this is still under trial, and no description can yet be given of it. The "Fiocchi" system consists of wrought iron cylindrical receptacles; when the apparatus has to be filled with ore, it is in a vertical position, and a temporary cover is fixed in one extremity. It is then placed in a horizontal position, and the working

cover, containing a steam-pipe, is then screwed on and made steam-tight. Steam, at from 60 lbs. to 80 lbs. pressure, is then turned on, which, at the outset, becomes water; but as this is drained off and the mass of ore becomes heated, the steam becomes dry, and the sulphur fuses, and is run off into proper receptacles. This system is adapted for rich ore, or ore that is porous, and the per-centage of sulphur recovered is much greater than with the *calcaroni*, with the great advantage that the sulphur ore can be rapidly turned into commercial sulphur, and realised in a short space of time. The cost of this is about £400, is rather heavy, hence the smaller mine owners prefer the old system of *calcaroni*. Finally, there is the "Orlando" system, which is the same as the Fiocchi, but the apparatus always remains horizontal. Four trains, each loaded with about fifteen hundredweight of ore, are run in on rails and remain during the fusion, the apparatus is made steam tight, and steam turned on. The advantage over the Fiocchi system is the greater facility and quickness in charging and discharging the apparatus. Sulphur refining is only carried on in Catania, and the season commences in October and ends in June. The refinery consists of a long oven in masonry, with arched roof, upon which are placed the cast-iron retorts, which are again covered by another arch, upon which are placed cast-iron boxes surrounded by brickwork, and with flues for the smoke and flame from the fire in order to keep them continually heated. The fire-grate is at one of the extreme bottom ends of the oven, and the gases and flames ascend by spiral openings, and play all round the retorts, and the smoke ascends by the flues to the cast-iron boxes, and thence to the chimney or stack. The sulphur is put into the cast-iron boxes, where it is fused, and by means of a valve it passes into the retorts, where it is transformed into gas, and thence by a special cast-iron pipe it passes into the condensers, which are cylindrical cast-iron vessels, and from the said condensers the refined sulphur, which has again become liquid, passes by a special aperture into cast-iron pans, so that it may gain the required temperature, and from thence it is ladled out into cast-iron forms or moulds of about one hundredweight capacity, or if roll-sulphur is required it is ladled into metallic moulds of the shape it is usually seen in commerce. Sublimed sulphur is manufactured in an oven, as described for the refined sulphur, but with only two retorts, and the gases, instead of going into the condensers, ascend into a large and specially constructed chamber, lined with bricks, which is hermetically closed, with the exception of a valve in the roof which opens automatically when the tension produced by the gases is too great for the strength of the chamber, and the gases as they enter the chamber at the necessary temperature, become immediately solid, and the sublimed sulphur falls into the form of flakes like snow.

General Notes.

Forests of Belgium.—About 16·6 per cent. of Belgian territory is devoted to woods and forests. There are 1,209,371 acres of woodland, divided among the provinces as follows:—Antwerp, 116,402 acres; Brabant, 69,589; West Flanders, 27,169; East Flanders, 27,265; Hainault, 108,469; Liege, 141,884; Limbourg, 97,052; Luxembourg, 380,614; and Namur, 240,927 acres. The per-centages of woods and forests (trees planted) to the total areas of some of the Belgian provinces is as follows:—Luxembourg, 36·86 per cent.; Namur, about 26·63; Liege, 18·94; Antwerp, 17·36; and Limbourg, 16·36 per cent. The annual receipts from the Belgian forests amount, on an average, to about £835,000, and this represents the amounts received from the sale of wood, and for hunting privileges, pasturage, &c. The average receipts per acre are about 14s. 4d.

Commerce of Japan. — The part taken by Japan in the commerce of the world is rapidly increasing; in fact, during the decade ending December, 1892, the increase was 150 per cent. The value of the imports, in 1892, amounted to £14,700,000, and of the exports to £11,400,000. Among the articles exported, silk holds the fourth place, with £6,000,000, next comes tea with £1,200,000 (the only customers for this article are Canada and the United States), metals with £840,000, and rice with £640,000. One article which causes surprise is matches, and these are exported, to the value of £320,000, to China, and even to England. An article, the exportation of which is rapidly increasing, is coal, as shown by the following figures—in 1884, £160,000, and in 1892, £400,000, to the great detriment of Australian coal. It is expected, however, that this increase in coal exports will be arrested by the great competition of the Tonquin coal which has made its appearance on the market. In the order occupied by the different countries to which Japanese exports are directed, France stands third with £3,480,000. Germany is credited with only £1,080,000. The imports comprise a variety of articles, chiefly sugars (£1,520,000), spun thread and cotton articles, £1,920,000, and raw cotton, £1,960,000. Japan is rapidly becoming an industrial country. Numerous cotton-spinning factories have been established there within the last three years, and the imports of raw cotton have risen in value from £120,000 in 1883, to £1,960,000 in 1892. As a result, the importation of cotton manufactures has fallen from £2,160,000 in 1888, to £880,000 in 1892, at the expense of English manufacturers. The two most important commercial ports in Japan are Yokohama and Kobé.

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FRIDAY, NOVEMBER 3, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Fortieth Session of the Society will be held on Wednesday, the 15th November, when the Opening Address will be delivered by SIR RICHARD E. WEBSTER, Q.C., M.P., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made :—

NOVEMBER 15. — Opening Address by SIR RICHARD WEBSTER, Q.C., M.P., Chairman of Council.

NOVEMBER 22.—"Conformation of the Horse from the Artistic Point of View." By CAPT. M. H. HAYES.

NOVEMBER 29.—"The Regulation of Street Advertising." By RICHARDSON EVANS.

DECEMBER 6.—"An Artist's View of Chicago and the World's Fair." By FREDERIC VILLIERS.

DECEMBER 13.—"Carriage-way Pavements for large Cities." By LEWIS H. ISAACS.

Papers for meetings after Christmas :—

"Automatic Balance of Reciprocating Machinery, and the Prevention of Vibration." By W. WORBY BEAUMONT.

"London Coal Gas and its Enrichment." By PROF. VIVIAN LEWES.

"The St. Pancras Electric Light Installation." By HENRY ROBINSON, M.Inst.C.E.

"Modern Development of Illustrated Journalism." By HORACE TOWNSEND.

"Experiments in Aeronautics." By HIRAM S. MAXIM.

"Automatic Gem and Gold Separator." By W. G. LOCKHART.

"The Adam Architecture in London." By PERCY FITZGERALD.

"Pewter." By J. STARKIE GARDNER.

Electric Signalling without Wires." By WILLIAM HENRY PREECE, F.R.S.

INDIAN SECTION.

The meetings of this Section will take place on the following Thursday Afternoons, at Half-past Four o'clock :—

January 18; February 15; March 8; April 5, 26; May 24.

FOREIGN AND COLONIAL SECTION.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four or Eight o'clock :—

January 23; February 20; March 6; April 17; May 1, 29.

APPLIED ART SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

January 30; February 13, 27; March 13; April 10; May 8.

CANTOR LECTURES.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock :—

HENRY BLACKBURN, "The Art of Book and Newspaper Illustration." Three Lectures.
November 27; December 4, 11.

PROFESSOR FRANK CLOWES, D.Sc., "The Detection and Measurement of Inflammable Gas and Vapour in the Air." Four Lectures.
January 22, 29; February 5, 12.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Traditional Foliage." Four Lectures.
February 19, 26; March 5, 12.

CAPTAIN W. DE W. ABNEY, C.B., F.R.S., "Photometry." Three Lectures.
April 2, 9, 16.

HENRY CHARLES JENKINS, A.M.Inst.C.E., "Typewriting Machines." Two Lectures.
April 30; May 7.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered by WALTER GARDINER, M.A., F.R.S., on "Plants: their Foes and Defences," on Wednesday evenings, January 3 and 10, 1894, at 7 p.m.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Wednesday, 1st November, at 4 p.m. Present :—Sir George Birdwood,

K.C.I.E., C.S.I., in the chair; Lionel R. Ashburner, C.S.I., J. A. Baines, I.C.S., Sir Steuart C. Bayley, K.C.S.I., C.I.E., Hyde Clarke, Walter H. Harris, C. M. Kennedy, C.B., Sir Raymond West, K.C.I.E., Sir Alexander Wilson, with Henry B. Wheatley, Assistant-Secretary, and S. Digby, Secretary of the Section.

Chicago Exhibition, 1893.

MEETING OF THE ROYAL COMMISSION.

A meeting of the Royal Commission was held on Tuesday, 31st ult., at 4.30 p.m. Present:—Sir Richard Webster, in the chair; Sir Frederick Bramwell, Bart., D.C.L., F.R.S., Sir Frederick Abel, K.C.B, D.C.L., D.Sc., F.R.S., William Anderson, D.C.L., F.R.S., Sir George Birdwood, K.C.I.E., C.S.I., LL D., M.D., Michael Carteighe, R. Brudenell Carter, F.R.C.S., Sir George Hayter Chubb, B. Francis Cobb, Prof. James Dewar, M.A., LL.D., F.R.S., Sir Henry Doulton, James Dredge, Walter H. Harris, W. B. Perceval, and Sir Owen Roberts, M.A., D.C.L., F.S.A.

EXHIBITION FINANCE.

It is reported that Auditor Ackerman's monthly statement of the Exposition's finances to September 30 shows that the Exposition is not only out of debt, but has a handsome balance in the treasury.

The amount realised so far from the sale of souvenir coins is $1,929,120; gate receipts for September, $2,263,038, against $1,694,518 for August; total gate receipts to end of September, $7,404,593; concession receipts for September, $843,240; for August, $578,520; total concessions to October 1, $2,600,307. The photographic receipts to September 30 were $137,426; total miscellaneous receipts, $669,195.

The total liabilities of the Exposition are only $97,212. Fire protection has cost $231,468, and the guard and secret service, $982,138. Total expenditure on account of construction, $17,944,742; miscellaneous disbursements, $6,260,947.

Total receipts from all sources, $25,234,199; total expenditure on all accounts, $24,205,690, leaving a balance of $1,028,508 in the treasury. The total expenditure on account of construction work and administration were $873,705, that for construction principally under contracts being $344,150.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS.

By Prof. W. Chandler Roberts-Austen, C.B., F.R.S.

Lecture IV.—Delivered March 27th*, 1893.*

The object of this lecture is to afford a guide to the metal work in the art collections in the South Kensington Museum, which are singularly rich in examples of special interest from a metallurgical point of view, and it is in this aspect alone that I can claim any authority in considering them.

The subject with which I have to deal is the "materials used for art metal work," but as they are treated from the point of view of the collections at South Kensington, it will be well to state some historical facts which might otherwise be omitted.

The range of metals and alloys at the disposal of the craftsman is really very wide, but he nevertheless restricts his efforts within narrow limits, and employs but few materials. The pure metals are seldom used, and have hardly any applications in art industries except when in union with other metals. A notable exception is, however, presented by wrought-iron work, which I do not propose to deal with, as it has already been admirably treated by Mr. Starkie Gardner. It may be sufficient to point out that the purer the iron is, the better suited it will be for hammering and twisting into delicate shapes, while the presence of some $\frac{2}{10}$ths per cent. of carbon, which does not impair its ductility, sensibly increases its durability and rigidity. Even gold is almost always employed with more or less alloying metal added to it, and the alloys of gold have, as I shall subsequently show, a very wide range of tint. Silver, also, is seldom used unalloyed.

* Some of the particulars contained in this lecture were given in a lecture delivered at South Kensington Museum in 1892, and some portions, relating to Japanese art metal work, formed the subject of a paper read before the Applied Art Section of this Society, which appeared in the *Journal* June 30, 1890.

The two series of alloys which have prominence in the history of art metal work are those of copper and tin, the bronzes, and the copper-zinc series, the brasses. Next in importance would come the lead-tin alloys, the pewters. Of the alloys of the precious metals, the gold-copper, the gold-silver, and the silver-copper are the most important.

A very beautiful modern chalice, destined for use in the church of S. Martin, Wonersh, was shown as a good example of art-work in pewter.

It may be well to take the bronzes first, and the important question at once suggests itself was copper employed before the general adoption of the alloy of copper and tin in industrial art? It is well known that the word copper is derived from Cyprus, famed for its copper, the island being under the special patronage of Venus, to whom copper was ultimately though not, I think, at first dedicated.

Berthelot has given us the analysis* of a little Chaldean statuette of a god, now in the Louvre, which is considered to date from 4000 B.C., and it proved to be of metallic copper. There is also an analysis by Berthelot† of the sceptre of the King Pepi I., a king of the 6th Egyptian dynasty. This sceptre, a cylinder 12 centimètres long, covered with hieroglyphics, is in our own British Museum, and its date is believed to be some 3,500 to 4,000 years B.C. It is of pure copper, probably derived from the mines in Mount Sinai, which are known to have been worked by the Egyptians in the 3rd dynasty.

From the standpoint of anthropology, however, copper plays an essentially different part in prehistoric culture now from what was assigned to it but a short time ago. Whereas it had been assumed that in Europe copper periods existed only in certain localities, Hungary, Ireland, and Spain finds of copper have recently increased to such an extraordinary extent that the assumption of a special copper age, which was in point of time prior to the bronze age, and contemporary with the later stone age, seems to archæologists now inevitable.‡

I cannot enter here into the discussion of the first appearance of bronze. I was inclined to accept the evidence which attributes the name bronze to Brundusium, for it seems clear that just as Cyprus was celebrated for its copper, Brundusium was famous for its manufacture of bronze, especially of mirrors, but my friend, Sir George Birdwood, sends me the following statement bearing upon the question:—

"I cannot find any connection between bronze and Brundusium. This first came into notice only in the 3rd century B.C., and apparently long before the Italian word, *bronzo*, was formed, all memory of any trade in bronze through Brundusium had been lost. The word appears in its English form first in the 16th century, and evidently from the Italian; and the Italian *bronzo* is said to mean, originally, "live coal"—and in reference to their alloy, points to its mode of preparation by burning. Brunette is the same word, and brown and burnt. The objects about us are many, our words for them very few!"

But with regard to the period of its introduction for industrial use, whatever may be the date of Schliemann's "first prehistoric city," Ilios, many of the objects found in it were certainly of nearly pure copper. Dr. Schliemann asked me to analyse two nails or pins which were exhibited, with the rest of his collection, at South Kensington. These contained respectively*:—

I.

Copper	97·83
Tin	·21
Iron	·90
Nickel and cobalt	traces
	98·94

II.

Copper	98·20
Iron	·75
Sulphur	·13
Tin	trace
	99·08

The metal examined was from the centre of the pins, and was freed, as nearly as might be, from the investing layer of carbonates and oxides.

I believe that the presence of tin is entirely accidental. Schliemann concluded, on the evidence supplied by these analyses, that all the objects from the first and second cities of Hissarlik were of copper, and indicated the existence of a pre-bronze age, and even if the date of these copper articles be no older than 1500 B.C., their occurrence is very useful in enabling the period at which tin was alloyed with copper to be defined, even roughly, for in the layer of deposits which Schliemann calls the third city, and identifies with Homer's

* "Ann. de Chim. et de Phys.," xii., 1887, p. 131.
† "Ann. Chim. et de Phys," xvii., 1889, p. 507.
‡ "Prehistoric Antiquities of the Aryan Peoples." Schrader and Jevons Edition. p. 191.

* Ilios, 1880, p. 251.

Troy (about 1200 B.C.). The articles I analysed were undoubtedly of bronze. M. Damour of Lyons also analysed some of the battle-axes from this third city and found them to contain:—

I.

Copper	95·80
Tin	3·84
	99·64

II.

Copper	90·67
Tin	8·64
	99·31

I found in other portions of the same axes:—

III.

Copper	93·80
Tin	5·70
	99·50

IV.

Copper	95·41
Tin	4·39
	99·80

Sir George Birdwood tells me that for a thousand years before 1200 B.C. the Phœnicians had been actively trading in the Levant, and their commerce was at its height 1500 B.C.

Our knowledge as to the first appearance of bronze has, however, received recently a somewhat astonishing piece of evidence. Dr. Flinders Petrie has found a rod of metal, which is believed—from the position in which it was found at Meydum—to date from the IVth Dynasty, about B.C. 3700. This rod was analysed by Dr. Gladstone,* who finds that it contains:—

Copper	89·8
Tin	9·1
Arsenic	·5
Antimony	traces
Iron	traces
Sulphur	traces
	99·4

So that we have here a specimen of bronze of 3700 B.C., which has about the ratio of nine copper to one tin, characteristic of far later, and even of modern bronzes.

Further evidence as to the composition of ancient bronze is, however, forthcoming. At the request of Sir John Donnelly, Secretary of the Science and Art Department, analyses were recently made,* under my direction, of certain objects in our own South Kensington collections, and a few antique bronzes in the British Museum. These analyses were made by Mr. A. Wingham, a chemist of great skill, and are absolutely trustworthy. Of the objects selected, probably the oldest is No. 82, and the next is No. 79. It is important to remember that the Etruscans were not dependent for tin solely on imports.

No. 79.—Bronze Figure of a Lion. Etruscan work. 5th century B.C. '73. 8-20. 251.

Analysis.

Copper	82·10
Tin	12·64
Lead	1·86
Zinc	·73
Iron	trace
	97·33

No. 82.—Fragment of Drapery found with leg of bronze statue. Greek sculpture. About B.C. 450. '86. 3-24. 7*a*.

Analysis.

Copper	84·49
Tin	9·47
Lead	5·31
Iron	trace
	99·27

There is, therefore, a clear case for the introduction of tin in Etruscan and Greek work in the 5th century before Christ. The presence of zinc is probably accidental.

But now we must consider the important point connected with the occurrence of lead and zinc. An eminent and careful authority, Dr. C. Drury Fortnum,† leans to the view that the presence of lead in bronze, indicated by Pliny, was due to the addition of the metal as an adulterant of the tin, and with a view to increase the fusibility of the alloy. No doubt tin was adulterated with lead; in fact, Pliny tells us that it was so; but my own opinion is that the fact that the presence of lead enables the bronze both to be more easily fused, and, above all, to assume a beautiful velvety-brown patina, was recognised far

* "Proc. Soc. Biblical Archæology," March, 1892.

* The numbers given over each analysis refer to the "Report on the Analyses of various examples of Oriental Art Metal Work in the South Kensington Museum, and other Collections," made under the direction of the author of this lecture by Mr. Arthur Wingham, 1892. Price 6d. It may be purchased at the South Kensington Museum.

† "A descriptive catalogue of the bronzes in the South Kensington Museum, 1876. Introduction.

earlier than has been supposed, and this supposition is sustained by the occurrence of lead in analyses No. 82 of the fragment of the Greek bronze, the date of which is about B.C. 450.

With regard to the presence of lead in large bronze works, the Florentine artists do not seem to have been very particular as to its amount. For instance, the description of the casting of the Perseus in the Loggia di Lanza at Florence is too well known to need repetition, and I will only refer to it to point out that, if Cellini's boastful account of the casting is true, there must be far more lead in it than the artist intended, for he says that, finding the metal was setting in the furnace before he had time to transfer it to the mould, he ordered all his pewter dishes and porringers, which were in number about two hundred, to be placed before the ducts through which the bronze had to run, and presently the bronze became fluid again, and the casting successfully accomplished.

Now, with regard to the presence of zinc, Pliny describes in much detail the various shades of colour presented by bronze, and it is of interest to fix the date, or at least the period, at which zinc was deliberately introduced, in view of the very important part played by zinc either as affecting the natural tint of the tin-copper alloys, or as influencing the colour of the patina produced by atmospheric action. In order to effect the introduction of zinc into bronze, it was only necessary to add zinc ores to the furnace charge, the metallic zinc became reduced from the ore and passed into the alloy. I have elsewhere expressed the view that brass, which was common enough in Roman time, was not much used in this country until my namesake, William Austen, in 1460, made the magnificent monument in brass which covers the greatness of Richard Beauchamp, Earl of Warwick.

No. 9.—ASTROLABE? Brass engraved. It appears to have been gilt, and is slightly inlaid with silver. It bears the date of the Hegira 598 (A.D. 1202), and was made at Damascus by Abdul Rahman, son of Iusuf. *Persian* or *Saracenic.* $9\frac{3}{4}$ in. by 8 in. 504. '88.

Analysis.

Copper	79·40
Arsenic	·157
Antimony	Nil.
Tin	1·125
Lead	2·145
Bismuth	Trace.
Iron	·350
Nickel	Trace.
Zinc, by diff.	16·823
Silver	Trace.
Gold	Nil.
	100·000

FIG. 1 shows an Astrolabe in the collection which closely resembles the one analysed.

No. 4.—CANDLESTICK (Fig. 2). Brass, inlaid with silver, and engraved with Arabic inscriptions recording Memlúk titles of the 14th century round base and neck and on other parts, divided by medallions of geometrical designs, and by rosettes of flowers. *Saracenic.* 14th century. H. 10 in., diam. 9 in. 4505. '58.

Analysis.

Copper	84·75
Arsenic	Trace.
Antimony	Nil.
Tin	2·360
Lead	·656
Bismuth	Trace.
Iron	·098
Nickel	Trace.
Zinc, by diff.	12·084
Silver	·052
Gold	Nil.
	100 000

No. 7, MORTAR (Fig. 3).—Brass, octagonal, chased with arabesques and Kufic inscriptions. Round the sides are projecting knobs, and on one side is a ring suspended from a bull's head. Found in the ruins of the city of Rhages. *Persian.* 10th or 11th century. H. $5\frac{1}{4}$ in., diam. 7 in. 466.'67.

Analysis.

Copper	68·19
Arsenic	Trace.
Antimony	Nil.
Tin	3·327
Lead	14·990
Bismuth	Trace.
Iron	·448
Nickel	Trace.
Zinc, by diff.	12·963
Silver	·082
Gold	Nil.
	100·000

No. 40.—VASE (Fig. 4), with handle and cover. *Phuldan.* Perforated brass; the cover surmounted by a knob; the handle formed by two dragons. *Nepal.* H. $11\frac{1}{2}$ in., diam. $7\frac{1}{2}$ in. 89. (I.S.) 1886.

Analysis.

Copper	78·58
Arsenic	Trace.
Antimony	2·037
Tin	·236
Lead	2·721
Bismuth	·070
Iron	·140
Nickel and cobalt	·068
Zinc	15·849
	99·701

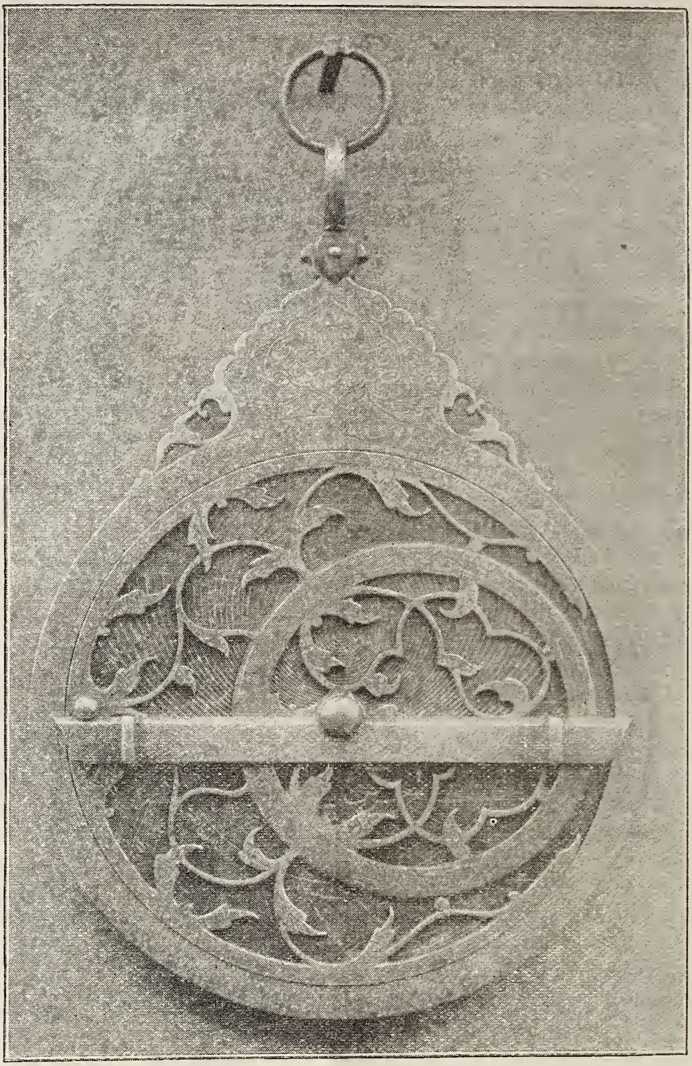

FIG. 1.—ASTROLABE.

NO. 53.—GUN (Fig. 5). Analyses of two samples, the first from the mouth end, the other from the tail or breech end. Lent by H.R.H. Prince of Wales. Length, 9 ft. 3 in.; bore, $3\frac{3}{4}$ in.

Copper	89·49
Arsenic	Trace.
Antimony	Trace.
Tin	4·893
Lead	2·118
Bismuth	Trace.
Iron	·238
Nickel	Trace.
Zinc	3·049
Gold	Nil.
Silver	Nil.
	99·788

Copper	85·93
Arsenic	Trace.
Antimony	Trace.
Tin	7·654
Lead	4·748
Bismuth	Trace.
Iron	·210
Nickel	Trace.
Zinc	1·501
Gold	Nil.
Silver	Nil.
	100·043

NO. 51.—BELL (Fig. 6), with dragons in relief, and incised inscription. Burmah. 05,219.

Analysis.

Copper	78·12

Arsenic	·221
Antimony	Nil.
Tin	19·18
Lead	1·913
Bismuth	·097
Iron	·105
Nickel	·114
Zinc	Nil.
Silver	·090
Gold	Nil.
	99·840

The bell contained on its outer surface a long inscription, of which the following is part (translation) :—

"We two, brother and sister, have given this bell as an offering to the seven Precious Things. In this attempt to merit Neh'ban our arrangement was as follows:—We took our own weight in gold, and in silver and bright copper and other metal (Laukad, the Pali word used, implies five metals—gold, silver, copper, iron, lead), and mixed them well together. In the year 1209 (1847, A.D.) in the hot season, at a fortunate hour, I had it moulded, setting my heart on giving it in alms.

"As I wrote the inscription I offered up abundant prayer that no enemies or troubles might come nigh me, and that I might attain Neh'ban.

"Then I dedicated it."

FIG. 2.—CANDLESTICK (ANALYSIS NO. 4).

The next analyses are similar to the above.

NO. 52.—BELL, bronze. Swinging shackle ornamented with two grotesque lions. With inscription, dated 1828 A.D. *Burmese.* H. 3 ft. 4 in., diam. 2 ft. 2 in. Presented by Commander C. Mc Laughlin, R.N. 76. (I.S.) 1884.

Analyses of Two Samples, the first taken from the Lip, the other from the Top.

Copper	78·50
Arsenic	·205
Antimony	·198
Tin	12·73
Lead	5·520
Bismuth	·215
Iron	·322

Nickel	Trace.
Zinc	1·749
Silver	·263
Gold	Nil.
	90·702

Copper	78·05
Arsenic	·154
Antimony	·229
Tin	12·85
Lead	6·292
Bismuth	·251
Iron	·210
Nickel	Trace.
Zinc	1·524
Silver	·218
Gold	Nil.
	99·778

No. 60.—Bronze Tortoise. *Modern Japanese.*

Analysis.

Copper	81·62
Tin	4·61
Lead	10·21
Iron	·22
Zinc	2·42
	99·08

Fig. 3.—Mortar (Analysis No. 7).

This sample, from a specimen in my own collection, was a very good and well-defined casting. Moderately hard and brittle.

Of all the bronze castings I have seen, two stand out in my memory as being specially impressive, one of these is 17th century Italian work, and the other modern Japanese. The former of these is the large statue in the magnificent Medici chapel of the Church of St. Lorenzo, Florence, of Ferdinand III. (1609), modelled by Gian da Bologna (Fig. 8), and cast by Pietro Tacca. Bologna's character must have presented a marked contrast to that of Cellini, for contemporary accounts represent him as being "honest, disinterested, industrious, obliging, and agreeable to all."* The statue is composed of different coloured bronzes, probably lightly gilt in parts, and the texture of the brocaded robes is wonderfully rendered, as is the fur cape. The statue in a second niche (Fig. 9) of Cosimo IV. (1620), was entirely by Pietro Tacca. The tints of the bronze are quite fresh, and can hardly have been impaired by age.

It seems to me that much Japanese work

* "Florence," by C. Yriarte. Paris, 1881.

presents singular analogies to that of the Italian Renaissance, and the second of the two works for which I have claimed special admiration is, fortunately, in our own collection in the South Kensington Museum. It is the wonderful incense holder (Fig. 7), with peacocks and pigeons in ordinary coloured bronze exquisitely modelled, and the casting must have been effected by the method of *cire perdue*. A brief description of the method of casting will be given subsequently. This incense holder is the work of Chokichi Kako, and it was exhibited in the Japanese Section of the Paris Exhibition of 1878. I hope it will be one of the next objects we shall be permitted to analyse, but I do not anticipate that it will differ much from characteristic Japanese bronzes, though it probably contains less lead than the bronze tortoise, of which analysis is given on p. 1012. Fifteen years have elapsed since then—a long period in the life of a Japanese; but the same artist is again represented at Chicago, this time with an even more important work. He has designed a series of twelve falcons, birds which have long been held in high esteem in

FIG. 4.—VASE (ANALYSIS NO. 40).

Japan. The varieties of plumage have given the artist free scope for all manner of dexterous experiments with the various alloys and patinas, in the use of which the Japanese have no rivals. The birds have been produced by the *cire perdue* process, and coloured by pickling. Upon one a tone of yellow and green gold has been arrived at; another is in a brown alloy; another, in black shakudo, glistens with wet; while yet another is of unpolished silver. Few birds present such delicate gradations in greys and browns; but these tints are admirably caught; while each bird is depicted in some characteristic attitude, which only lengthened study of the original has enabled the artist to convey.

Specimens of ancient bronze analysed by E. J. Maumené* gave the following results :—

* "Comptes Rendus," lxxx. 1875, p. 1,009.

	I.	II.	III.	IV.
Copper	86·38	80·91	88·70	92·07
Tin	1·94	7·55	2·58	1·04
Antimony	1·61	0·44	0·10	—
Lead	5·68	5·33	3·54	—
Zinc..........	3·36	3·08	3·71	2·65
Iron..........	0·67	1·43	1·07	3·64
Manganese....	—	trace	—	—
Silica	0·10	0·16	0·09	0·04
Sulphur	—	0·31	—	—
	99·74	99·21	99·79	99·44

Mr. Alfred Gilbert, A.R.A., the excellence of whose metal castings is well known, considers that the following composition is very suitable for casting by the *cire perdue* methods :—

Copper	91·40
Tin	5·70
Lead	2·90
	100·00

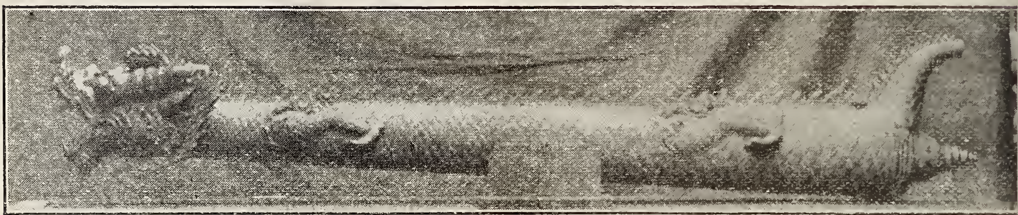

FIG. 5.—GUN (ANALYSIS NO. 53).

H. Morin* has shown that the black patina of certain Oriental bronzes is due to the presence of lead, and MM. Christofle and

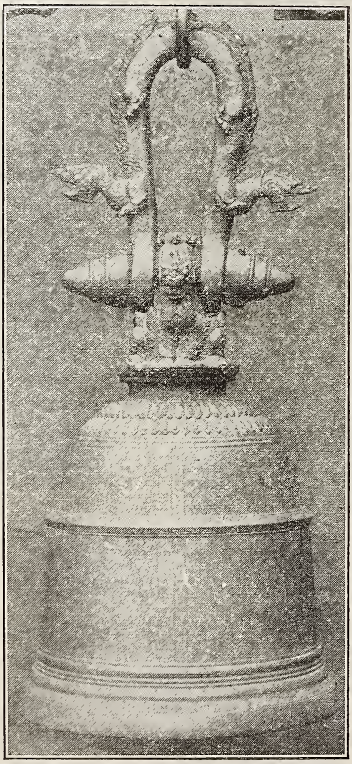

FIG. 6.—BELL (ANALYSIS NO. 51).

Bouilliet* confirm this view, but state that the patinas may be produced of a wide range of tint on pure electrolytic copper by the use of suitable reagents, and although they provok-

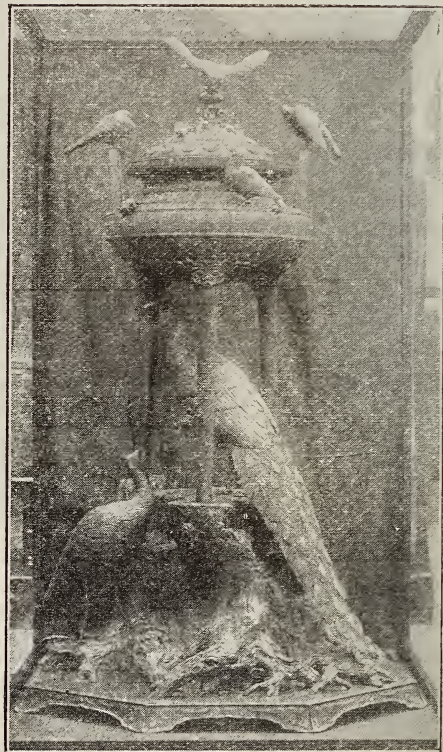

FIG. 7.—INCENSE HOLDER.

ingly refrain from "disclosing" what these reagents are, they say that the tint is due to two different molecular states of cuprous oxide.

* "Comptes Rendus," vol. 78, 1874. 811.
Ibid. 1019.

Now doubtless the artificial patina is, to a considerable extent, more dependent on the nature of the pickling than on the composition of the copper alloy used, but it is nevertheless true that there are solutions which give a varied range of tints if the compositions of the copper be altered but a little, as this diagram will show.

It would, at first sight, appear to be useless in London to think of composing bronze so as to give a pure patina. Take, for instance, one of our last-erected monuments—the equestrian statue of Lord Napier of Magdala, which is placed opposite the Guards Memorial in Waterloo-place. A few months ago the patina began to form, and iridescent tints played over his features, and unsightly rain stains ran down his horse; now the layer is thickening, and grey brown tint deepening, but there is no velvety brown of oxide, or green and blue of carbonate. The soldier, field-glass in hand, is sternly looking away from the Athenæum and the learned societies, as if conscious that, in the present state of the London atmosphere, he was beyond the aid of science, for science has clearly stated that, so long as bituminous coal is burnt in open fire-places, London must be smoky, and man and horse alike will soon be covered with the black pall of soot and sulphide of copper which now enshrouds the unfortunate occupants of adjoining pedestals, Franklin and Lord Clyde.

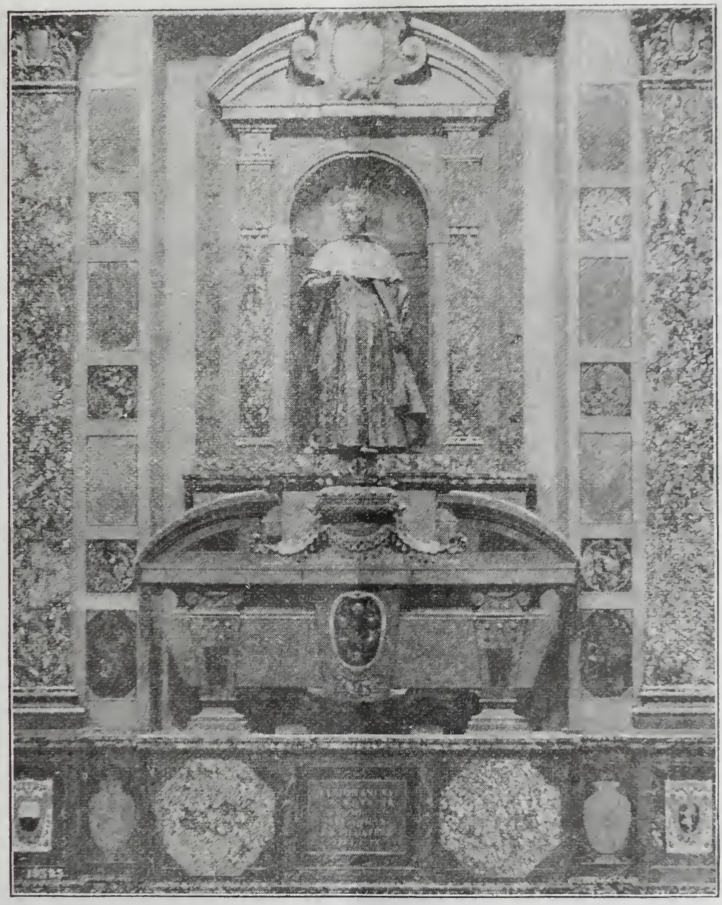

Fig. 8.—Tomb of Ferdinand III. at Florence.

In Mr. Alfred Gilbert's monumental fountain, in memory of the late Lord Shaftesbury, which is placed at the Piccadilly end of Shaftsbury-avenue, an attempt has been made to enrich the composition by the sparing use of coloured patina among the marvelously beautiful details of the work, the metal itself nearly approaching, I believe, gun-metal in compo-

sition. A winged aluminium figure, moreover, surmounts the structure, and the effect of weather upon it will be watched with great interest. But can nothing be done to preserve our statues in the atmosphere of London? Much, I am satisfied, may be done. When the metal has once obtained a coating of patina, it should be carefully wiped, to remove extraneous deposits of soot. Look at the paws and flanks of the sphinxes which guard Cleopatra's Needle on the Embankment. In the evenings they form a centre of attraction for the London children, and the more adventurous clamber over the beasts and slide down their haunches, the dark patina of which has become beautifully polished, although there does not appear to be any wear of the finer details of the modelling. When Trafalgar-square was more used as a meeting place than it is now, and when the base of Nelson's column served

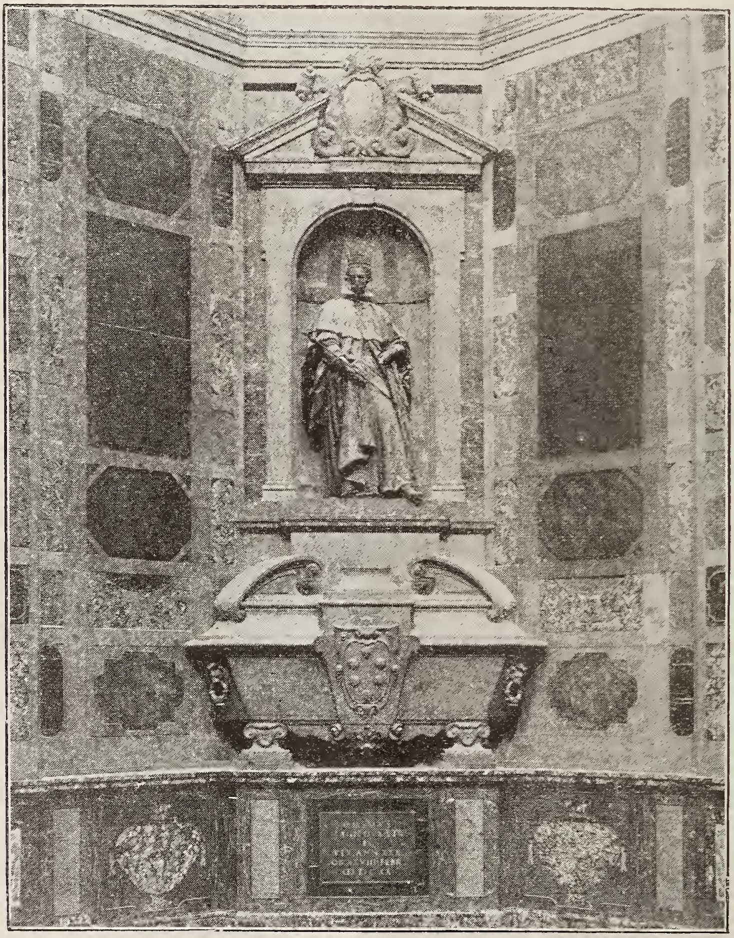

FIG. 9.—TOMB OF COSIMO IV. AT FLORENCE.

as a rostrum, the paws of the lion were beautiful in their lustrous polish over the dark patina; and in several London decorative works in bronze unexpected patches of polished patina are to be seen which owe their lustre to the fact that they form a convenient rest to some lounging *habitué* of the spot. The polish on the lions in Trafalgar-square, and on the sphinxes on the Embankment, afford the best indications of what might be done by careful wiping, and deserve attention as examples of the unconscious services to art which have been rendered by the agitator and the "arab."

I have finished with the bronzes for the present, and will turn to a singular group of alloys in which the copper and tin are subordinated to zinc itself, and these alloys are well illustrated by the Indian *bidri* wares.

The *bidri* objects, Nos. 36 to 39, are a peculiar series of alloys. They are chiefly zinc, containing a quantity of copper and lead, with smaller amounts of tin and iron. The amount of lead in No. 37 is remarkably low, and, as it is very difficult to purify zinc from lead, it would appear that a very pure ore of zinc must have been used in the preparation of this metal. Apparently copper is the predominating metal associated with zinc in this *bidri* alloy. From this it is probable that No. 38, which contains none of it, is not Indian, but Hungarian, as the Museum description suggests. In the other specimen, to which a doubtful origin is assigned (No. 39), copper is present but in small proportion, tin being the secondary metal. This indicates that it is not Indian.

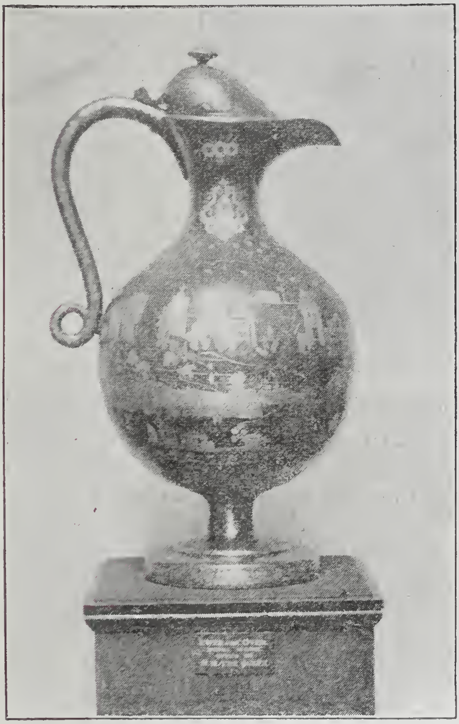

FIG. 10.—EWER, WITH COVER.

These works are beautifully damascened with silver in the form of thin plates, which are let in to undercut depressions in the surface of the metal of which the objects are made. It then takes a fine dark colour by exposure and tarnish.

No. 36.—EWER with COVER. Oxidised metal, damascened with silver. *Indian*, modern. H. 2 ft. 11 in., diam. 2 ft. 4 in. Given by her Majesty the Queen. 587.—'54.

Analysis.

Lead	1·298
Copper	3·510
Iron	·049
Silver	Nil
Zinc, by diff.	95·143
	100.000

No. 38.—BOTTLE with COVER. Metal, with raised chasing of flower and leaf pattern, covered with gold and silver foil. *Hungarian* or *Indian* Latter half of 17th century. H. $14\frac{3}{8}$ in., diam. $5\frac{7}{8}$ in.

FIG. 11.—BOTTLE, WITH COVER.

Analysis.

Lead	·956
Tin	·346
Iron	·084
Copper	Nil
	1·386
Zinc, by diff.	98·614

No. 38A.—VASE. Oxidised metal, damascened with silver. *Indian*, modern. H. 23 in., diam. 22 in. Given by Her Majesty the Queen. 585.—'54.

Analysis.

Lead	1·437
Tin	Trace.

Iron	·039
Copper	6·905
	8·381
Zinc, by diff	91·619

A singular case in which bronze, brass, and a little gold are combined, has already been described in a lecture delivered before this Society, on "Alloys used in Art Metal Work."

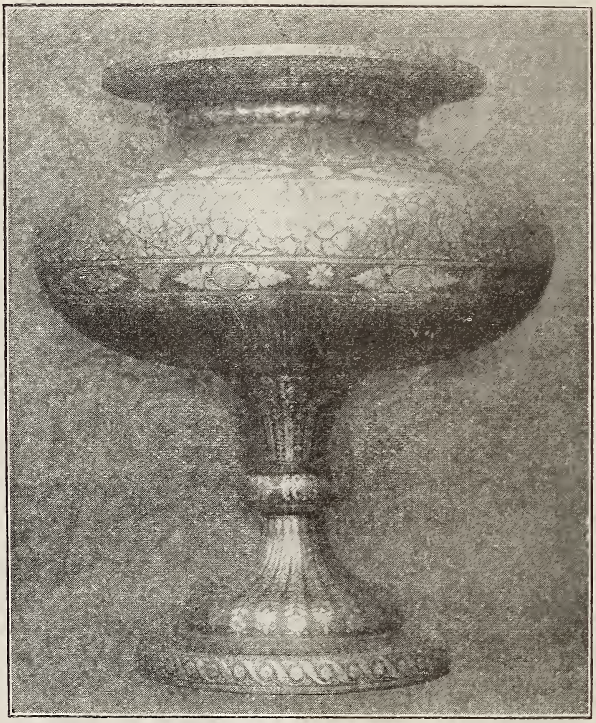

Fig. 12.—Vase (Analysis No. 38a).

No. 54.—Hanuman; the monkey ally of *Rama*; copper and brass, cut through to show process of casting. *Madras*. Modern. H. 4 in.—726.

This specimen of art metal work is of peculiar interest, insomuch as it was apparently a compound casting showing on its surface two dis-

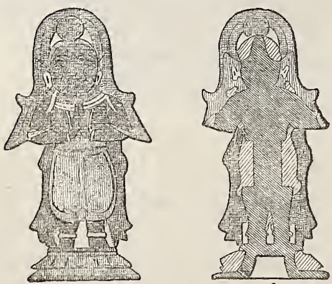

Fig. 13.

tinct metals, viz., bronze and brass, very much interspersed. The figure was not of one metal altered in colour in parts by superficial treatment, as inspection showed the colour to be due to the metal itself. Owing to the intermixture of the metals—the way in which they protruded one beyond the other at different points, and the small quantity at parts of one metal over the other such as the bracelets, armlets for example—it was difficult to understand from outside examination how these figures were made. With the object of solving the question, it was considered that some light might be thrown on the subject if the casting were cut in halves from top to bottom. This was done, and immediately the whole process was explained, as it is quite clear that a core of copper was originally cast, of a shape showing due regard to the result desired, and that the brass was cast round the copper.

From what is known in connection with small Oriental castings, it is probable that the following process has been employed in the production of these double castings. First, a model has been carved in wax, of a shape and size necessary to bring out the copper where that metal is required at the surface, and leaving space where the yellow surface is desired for the future casting of brass. This

wax model has then been moulded, the mould heated and the wax melted out, after which the copper has been cast in the mould. Then round this half figure, with its prominent parts, where necessary, more wax has been cast, and carved into the shape of the figure ultimately required. The whole has then been moulded, the wax removed as before, and the brass run into the mould, filling up the spaces existing between it and the copper core in the centre. The double casting has then been removed, the brass filed down, wherever it might accidentally and unnecessarily have covered the copper until the red metal was exposed, the whole being then chased and completed.

This casting is probably about 40 years old, and was made in Madras. The art of double casting, as represented by this figure, is very old (a thousand years or more), and has been practised at, and almost entirely confined to, the east coast of the Madras Presidency.

Mr. Havell, of the School of Art of Madras, who has been engaged on a survey of art manufactures for the Government, reported in 1887, that these castings were no longer made. Mr. C. Purdon Clarke thinks that if this be true it is probably due to the high cost of production.

The rest of my remarks will be mainly devoted to the questions of patina and texture. The standard fineness of gold and silver wares is, as is well known, vigorously guarded by law, and articles of gold may only vary between the limits of 9 carats, or 37·5 per cent., and 22 carats, 91·66 per cent. of the precious metal, while silver-work always contains 92·5 per cent. of silver. In the latter case, the rigid adherence to the old standard of England, while securing integrity in the productions of the silversmiths, has, it is to be feared, exerted a prejudicial influence on the development of metal work. In this custom has much to answer for: we have become so accustomed to see wares of the precious metals with resplendent surfaces, that the public will barely tolerate, and certainly do not appreciate, the film of varnish which silver acquires when exposed to the atmosphere; we seem to have entirely shut ourselves out from the use of a large series of alloys, the beauty of which depends on the tarnish they gain, either by time or exposure, or by the far more rapid action of chemical agents.

Take the case of "presentation plate"—quite apart from the terrible examples presented by many of the articles which generally serve for this purpose—the question of weight always receives attention; the price is not paid for the craftsmanship, but the weight, the number of ounces, and not the originality of treatment, too often considered to be far more important in determining the choice. In the case of metal work, we have been warned that such absence of "perception is fraught with infinite mischief, direct or indirect, to the development of art among us, tending, as it does, to divorce from it whole classes of industrial production, and incalculably narrowing the field of beauty in our lives."* The law is in no small measure responsible for the limitation of material, as the use of varied alloys in silver work is forbidden, so that the very restrictions which in the past have secured honesty in work, have been fatal to progress in art.

[*To be continued.*]

Miscellaneous.

THE INCREASE IN THE RUSSIAN POPULATION.

M. E. Fournier de Flaix, in a recent report upon Russian progress, says that the extraordinary increase of the Russian population in the 19th century arises much less from her annexations than from the high birth-rate of the race. In 1722, the Russian Empire, the empire of Peter the Great, only had a population of 14,000,000; in 1793, at the commencement of the wars of the revolution, Russia had 36,000,000 inhabitants; and 45,000,000 in 1815. During the 18th century the various census enumerations showed the following results:—1722, 14,000,000; 1742, 16,000,000; 1762, 19,000,000; 1782, 28,000,000; and in 1796, 36,000,000 of inhabitants. In the 19th century the figures were as follows:—In 1812, 41,000,000; 1815, 45,000,000; 1835, 60,000,000; 1851, 68,000,000; 1859, 74,000,000; 1867, 81,000,000; 1872, 86,000,000; 1882, 103,000,000; 1886, 113,000,000; 1889, 115,000,000; and in 1893, 125,000,000. From 1796 to 1893, that is to say, in 97 years, the increase amounted to 89,000,000, or 917,000 annually. It results from the above that the proportion of the increase has more than trebled during the 19th century. In 1889, the population was distributed as follows;—Russia in Europe, 86,782,574; Poland, 8,385,807; and Finland, 2,938,785; total 97,506,785. Asiatic Russia had a population of 17,719,748, distributed as follows:—Caucasia, 7,536,828; Steppes of Kirghy, 2,000,970; Turkestan, 3,642,389; and Siberia, 4,538,691. According to these figures, if Russia lost Poland, Finland, and her new Central Asiatic provinces, she would still have 90,000,000 of inhabitants, pos-

* Sir Frederick Leighton.

sessing an extraordinary power of increase. If even she lost the Baltic provinces—Courland, 676,000 inhabitants; Lithuania, 392,000; Livonia, 1,229,000; Podolia, 2,429,000; Bessarabia, 1,588,000; or a total of 6,504,000—her population would still be enormous. In 1885, the distribution of the population according to race, was as follows:—Russians, 72,637,000; Poles, 5,889,000; Lithuanians, 1,859,000; Slavs, 125,000; Germans, 1,314,000; Scandinavians, 328,000; various Europeans, 965,000; Armenians, 1,010,090; Persians and Kurds, 137,000; Tziganes, 16,000; Finns, 2,181,000; Caucasians, 2,590,000; Turcoman Tartars, 10,309,000; Mongolians, 793,000; &c. The proportion of Russians proper, which was large in 1884, is very much greater at the present day, this group amounting to over 80,000,000. The statistics of marriages, births, and deaths for 1889—the latest available—are as follows for the whole of the Russian Empire:—Marriages, 972,146; births, 5,206,712; and deaths, 3,640,220, thus leaving a surplus of 1,566,402. The average surplus for the years 1884-1887 was:—1,663,327 in European Russia; 157,979 in Poland; and 38,130 in Finland, giving thus a yearly surplus of more than 2,000,000 for the Empire. The great majority of the population of Russia being agriculturists, they dwell in villages; and in 1886 the division of population in urban and rural appeared as follows:—European Russia, 9,964,760 urban population and 71,760,425 rural; Poland, 2,125,458 and 5,834,846; Finland, 191,620 and 1,984,801; Caucasus, 669,085 and 6,615,462; Siberia, 345,071 and 3,968,609; and Central Asia, 651,831 and 4,675,267, making a total of 13,947,825 urban and 94,063,353 rural inhabitants. In 1886, there were 12 towns with a population of 100,000 and above; 22 towns with from 99,000 to 50,000 inhabitants. As regards immigration and emigration, during the period 1856-1888 there was an excess of emigration over immigration, in the case of Russians, of 1,146,052, and a surplus of immigration of 2,304,717 foreigners during the same time. Emigration is now on the increase.

General Notes.

Arts and Crafts Exhibition.—The first lecture of a course arranged in connection with the Arts and Crafts Exhibition was delivered at the New Gallery, on Thursday evening, 2nd inst., by Mr. William Morris, on the "Printing of Books." The lectures to be given on the following Thursday evenings are as follows:—Nov. 9th, on "Some Ornamental Offshoots of the Italian Renaissance," by Mr. Lewis F. Day. Nov. 16th, on "The Value of a Catholic Spirit in Art," by Mr. Selwyn Image. Nov. 23rd, on "The Use of Ornament," by Mr. Walter Crane. Nov. 30th, on "Mosaic," by Prof. W. B. Richmond, A.R.A.

Lectures on Sanitation of Industries and Occupations.—The first lecture of a course on the "Sanitation of Industries and Occupations" was delivered by Dr. Newsholme, on "Occupation and Mortality," at the Sanitary Institute, on Thursday evening, 2nd inst. The lectures to be delivered on succeeding Thursday evenings are as follows:—Nov. 16th, "Mineral (Non-Metallic) Dusts, the Manufacture of Pottery, &c.," by Dr. J. T. Arlidge. Nov. 23rd, "Metallic Dusts, Cutlery, Tool-making, and other Metal Trades," by Dr. Sinclair White. Nov. 30th, "Textile Manufactures, Silk, Cotton, Woollen, and Linen Industries," by Dr. J. T. Arlidge, M.D. Dec. 8th (Friday), "Metallic Poisons, Lead, and Arsenic," by Prof. T. Oliver. Dec. 14th, "Manufacture of Alkalis and Acids," by Prof. Watson Smith.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 6...Engineers, Westminster Town-hall, S.W., 7½ p.m. Mr. R. Nelson Boyd, "Collieries and Colliery Engineering."

Chemical Industry (London Section), Burlington-house, W., 8 p.m. 1. Mr. J. Scarisbrick, "Spirit Assaying by Weight." 2. Mr. P. W. Draper, "Estimation of Alizarin and Allied Colouring Matters."

Tuesday, Nov. 7...Biblical Archæology, 37, Great Russell-street, W.C., 8 p.m. 1. Mr. P. le P. Renouf, "Where was Tarshish?" 2. Mr. T. G. Pinches, "The Discoveries of the American Exhibition at Niffer."

N.E. Coast Inst. of Engineers and Shipbuilders, Durham College, Newcastle-on-Tyne, 8 p.m. 1. Address by the President. 2. Mr. W. Hök, "A Method of Comparing Steamship Performances and of Estimating Powers and Speeds of Ships."

Wednesday, Nov. 8...Geological, Burlington-house, W., 8 p.m. 1. Mr. W. J. Clunies Ross, "The Geology of Bathurst, New South Wales." 2. Mr. J. W. Evans, "The Geology of Matto Grosso, Brazil." 3. Mr. George M. Dawson, "Notes on the Occurrence of Mammoth Remains in the Yukon District of Canada, and in Alaska."

Entomological, 11, Chandos-street, W., 7 p.m. 1. Messrs. Henry J. Elwes and James Edwards, "A Revision of the Genus *Œneis*." 2. Mr. W. L. Distant, "The Homopterous Genus *Pyrops*, with descriptions of two new Species." 3. Professor E. B. Poulton, "The Sexes of Larvæ emerging from the successively laid Eggs of *Smerinthus populi*."

Thursday, Nov. 9...Electrical Engineers, 25, Great George Street, W., 8 p.m. Prof. George Forbes, "The Electrical Distribution of Power."

Friday, Nov. 10...Junior Engineering, Westminster Palace Hotel, S.W., 8 p.m. Presidential address by Mr. J. Wolf Barry.

Physical Science Schools, South Kensington, S.W., 5 p.m. 1. Prof. S. Young, Prof. Barrett, and Mr. Thomas, "The Separation of Three Liquids by Fractional Distillation." 2. Prof. S. Young, "The Critical Constants of Various Ethers." 3. Mr. J. Gillett, "An Instrument for Drawing Conic Sections."

Journal of the Society of Arts.

No. 2,138. Vol. XLI.

FRIDAY, NOVEMBER 10, 1893.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

Notices.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One Hundred and Fortieth Session of the Society will be held on Wednesday, the 15th November, when the Opening Address will be delivered by Sir Richard E. Webster, Q.C., M.P., Chairman of the Council. Previous to Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting. The following arrangements have been made:—

November 15. — Opening Address by Sir Richard Webster, Q.C., M.P., Chairman of Council.

November 22.—"Conformation of the Horse from the Artistic Point of View." By Capt. M. H. Hayes.

November 29.—"The Regulation of Street Advertising." By Richardson Evans.

December 6.—"An Artist's View of Chicago and the World's Fair." By Frederic Villiers.

December 13.—"Carriage-way Pavements for large Cities." By Lewis H. Isaacs.

Papers for meetings after Christmas:—

"Automatic Balance of Reciprocating Machinery, and the Prevention of Vibration." By W. Worby Beaumont.

"London Coal Gas and its Enrichment." By Prof. Vivian Lewes.

"The St. Pancras Electric Light Installation." By Henry Robinson, M.Inst.C.E.

"Modern Development of Illustrated Journalism." By Horace Townsend.

"Experiments in Aeronautics." By Hiram S. Maxim.

"Automatic Gem and Gold Separator." By W. G. Lockhart.

"The Adam Architecture in London." By Percy Fitzgerald.

"Pewter." By J. Starkie Gardner.

"Electric Signalling without Wires." By William Henry Preece, F.R.S.

"Railway Extension in India." By Joseph Walton.

"The Petroleum Fields of India: their Present and Future." By R. D. Oldham.

"Indian Currency." By J. Barr Robertson.

"Telegraphic Communication between England and India: its present Condition and Future Developments." By E. O. Walker, M.Inst.C.E., C.I.E.

"The Material Resources of Chota Nagpore." By J. F. Hewett.

Indian Section.

The meetings of this Section will take place on the following Thursday Afternoons, at Half-past Four o'clock:—

January 18; February 15; March 8; April 5, 26; May 24.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesdays, at Half-past Four or Eight o'clock:—

January 23; February 20; March 6; April 17; May 1, 29.

Applied Art Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 30; February 13, 27; March 13; April 10; May 8.

Cantor Lectures.

The following courses of Cantor lectures will be delivered on Monday Evenings, at Eight o'clock:—

Henry Blackburn, "The Art of Book and Newspaper Illustration." Three Lectures.

Lecture I.—November 27.—*The Illustrator of to-day.*—Education of the artist—Drawing for reproduction—Modern methods and requirements—Influence of photography on the illustrator—Examples of drawings for reproduction, good and bad.

Lecture II.—December 4.—*The Engraver.*—The various methods of reproducing drawings and photographs for the press—The substitution of photographic and mechanical engraving for handwork—Specimens of the newest processes of illustration.

Lecture III.—December 7.—*The Author.*—His part in the illustration of books—His handwriting—The decorative page—Examples of illustration—Archaic decorative, topical—The Book of the Past—The Book of the Future.

PROFESSOR FRANK CLOWES, D.Sc., "The Detection and Measurement of Inflammable Gas and Vapour in the Air." Four Lectures.
January 22, 29; February 5, 12.

HUGH STANNUS, F.R.I.B.A., "The Decorative Treatment of Traditional Foliage." Four Lectures.
February 19, 26; March 5, 12.

CAPTAIN W. DE W. ABNEY, C.B., F.R.S., "Photometry." Three Lectures.
April 2, 9, 16.

HENRY CHARLES JENKINS, A.M.Inst.C.E., "Typewriting Machines." Two Lectures.
April 30; May 7.

JUVENILE LECTURES.

Two lectures, suitable for a juvenile audience, will be delivered by WALTER GARDINER, M.A., F.R.S., on "Plants: their Foes and Defences," on Wednesday evenings, January 3 and 10, 1894, at 7 p.m.

FOREIGN & COLONIAL SECTION.

A meeting of the Committee of the Foreign and Colonial Section was held on Tuesday, 7th November, at 4.30 p.m. Present:—C. M. Kennedy, C.B., in the chair; Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Lieut.-General Sir Andrew Clarke, G.C.M.G., Francis Cobb, W. B. Perceval, Admiral Sir Erasmus Ommanney, C.B., Sir Saul Samuel, K.C.M.G., C.B., with Henry B. Wheatley, Assistant-Secretary, and Edward Cunliffe-Owen, C.M.G.

Proceedings of the Society.

CANTOR LECTURES.

ALLOYS.

BY PROF. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

Lecture IV.—Delivered March 27th*, 1893.

[*Concluded from page* 1019.]

The Japanese have long had the secret of the preparation of a series of alloys in which the precious metals are used in such a manner as to deliberately sacrifice the metallic lustre, and, in the case of gold, even its distinctive colour, for the sake of producing other definite effects. The brilliancy of gold and silver in their natural state is employed by this artistic nation merely to heighten the general effect of a design, and the result of centuries of patient labour is that the Japanese art metal worker possesses a series of alloys which rival the palette of the painter in range of tint. The nature of the alloys has already been fully described in the lecture to which I have referred, and I will, therefore, merely say that one class of them consist of copper alloys allied to the bronzes, but in which gold and silver replace tin and zinc. The history of their evolution would be most interesting to develop, for the wave of Indian colonisation reached Japan in the 6th century of our era, and that would appear to be the earliest period at which such alloys could have been adopted for artistic purposes by the Japanese, "a race which possesses the artistic instinct in certain of its developments in a greater degree than any other in our time. With them the sense of decorative distribution, and of subtle loveliness of form and colour is absolutely universal, and expresses itself in every most ordinary appliance of daily life, overflowing, indeed, into every toy or trifle that may amuse an idle moment."* There are hundreds who will visit the cases of this Museum, and will bestow appreciative admiration on the Japanese wares, but there are very few who know how the varied effects are produced. Let me, therefore, direct attention to a few selected objects and photographs. Take the simplest case first. Here is a plate (specimen shown) of brown bronze. There is no attempt at producing effect by a raised surface, the artist has simply chosen a plate of bronze, some $8\frac{1}{2}$ inches in diameter. He has cut a design into the plate, and has inlaid that design with a black alloy; wherever he has scooped out the drawing of this beautifully graceful bird he has inlaid the alloy, which now appears bluish-black, and he has taken a darker variety of the alloy, and has deepened the effect of the wing and tail feathers, and has in that way produced exactly the effect of an Indian-ink painting, in a dark and comparatively light shade. Now, what are the alloys the Japanese use, and how is the colour produced? The following analyses show the composition of the more important of them.

The first is called "shaku-do;" it contains, as you will observe from Analyses I. and II.,†

* Sir F. Leighton. Presidential Address National Association for the Advancement of Art. "Transactions," 1888, p. 22.

† Analyses Nos. I. and III., both on sword ornaments of the finest quality, are by Mr. Gowland, of the Imperial Japanese Mint at Osaka; Nos. II. and IV. by Professor Kalischer, "Ding. Polyt. Journ.," ccxv., 93.

Shaku-do.

I.

Copper	94·50
Silver	1·55
Gold	3·73
Lead	·11
Iron and Arsenic	traces.
	99·89

II.

Copper	95·77
Silver	0·08
Gold	4·16
	100·01

in addition to about 95 per cent. of copper, as much as 4 per cent. of gold. Mr. Gowland, an eminent authority on Japanese metal work, tell us that shaku-do has never been used for very large works. It has, however, been erroneously stated that a colossal statue, cast at Nara in the 7th century, is made of it. The quantity of gold is, really very variable, and certain specimens I have analysed contain only 1·5 per cent. of the precious metal. The next important alloy used by the Japanese is called "shibu-ichi," and the following are typical analyses:—

Shibu-ichi.

III.

Copper	67·31
Silver	32·07
Gold	traces.
Iron	·52
	99·90

IV.

Copper	51·10
Silver	48·93
Gold	·12
	100·15

There are many varieties of it, but in both these alloys shaku-do and shibu-ichi, the point of interest is that the precious metals are, as it were, sacrificed in order to produce definite results, gold and silver, when used pure, being employed very sparingly to heighten the general effect. In the case of shaku-do, we shall see presently that the gold appears to enable the metal to receive a beautiful rich purple coat or patina when treated with certain pickling solutions, while shibu-ichi possesses a peculiar silver-grey tint of its own, which, under ordinary atmospheric influences, becomes very beautiful, and to which the Japanese artists are very partial. These are the principal alloys, but there are several varieties of them, as well as combinations of shaku-do and shibu-ichi in various proportions, as, for instance, in the case of kiu-shibu-ichi, the composition of which would correspond to one part of shaku-do rich in gold, and two parts of shibu-ichi rich in silver. The precious metals are deliberately sacrificed with a view to obtain a definite effect, a distinct tint that is, in the patina, and if gold and silver are employed pure, it is only to heighten the general effect.

With regard to the use of pickling solutions, so far as I have been able to ascertain, they are made up respectively in the following proportions, and are used boiling:—

	I.	II.	III.
Verdigris*	438 grains	87 grains	220 grains.
Sulphate of copper	292 "	437 "	540 "
Nitre	—	87 "	—
Common salt	—	146 "	—
Sulphur	—	233 "	—
Water	1 gallon	—	1 gallon.
Vinegar	—	1 gallon	5 fluid drachms.

* Sulphate of iron may sometimes replace verdigris.

That most widely employed is No. I. When boiled in No. III. solution, pure copper will turn a brownish red, and shaku-do, which, you will remember, contains a little gold, becomes purple. And now you will be able to appreciate the effect of small quantities of metallic impurity as affecting the colour resulting from the action of the pickle. Copper containing a small quantity of antimony gives a shade very different from that resulting from the pickling of pure copper. But the copper produced in Japan is often the result of smelting complex ores, and the methods of purification are not so perfectly understood as in the West. The result is that the so-called "antimony," or shiro-me, of the Japanese art metal-workers, which is present in some alloys, is really a complex mixture con-

taining copper, lead, arsenic, and antimony, so that a metal-worker has an infinite series of materials at command with which to secure any particular shade; and these are used with much judgment, although the scientific reasons for the adoption of any particular sample may be hidden from him. It is strictly accurate to say that each particular shade of colour is the result of minute quantities of metallic impurity, and a few examples will, I trust, make it clear that the Japanese arrange true pictures in coloured metals and alloys.

The action of these solutions is remarkable. You have copper to which a small amount of silver and a small amount of gold are added. The amount of gold may be variable, and artificers often take credit for putting in much more than analysis proves to be present, but

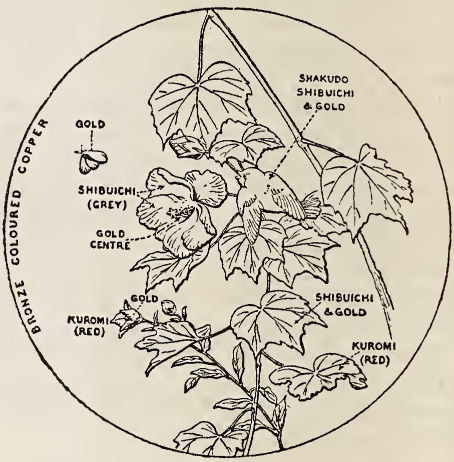

FIG. 14.

a small amount of gold, it may be only one per cent., is sufficient to entirely change the character of the copper, and when you come to treat it by pickling solutions, you get a totally different result from that which would result from the employment of pure copper. The series of alloys, known as shibu-ichi, vary in composition. Sometimes it will contain one half silver and the rest copper, often only one-third silver, the bulk of the alloy being copper; but in all cases the alloys assume, either by handling, by exposure to ordinary atmospheric influences, or by pickling, a beautiful series of light and dark grey tints greatly admired by the Japanese, who employ the alloy in almost all pieces of metal work. [The reader should refer to the report to which reference has been made, which gives the composition of a series of plates of metal, brass, shaku-do, shibu-ichi, and copper, which were specially prepared to show the texture and tints of various metals and alloys employed by the Japanese. They are modern, and far from being the best examples which could be obtained, but they are nevertheless very instructive.]

Fig. 14 represents a plate $18\frac{1}{2}$ inches in diameter. It is not in the South Kensington collection, but it is so typical that it may as well be taken as an example as any other. A plain surface of copper has first been taken, the design has been drawn upon it, and each leaf or flower has been scooped out and undercut. The leaf or flower would then be made of a particular alloy, say purple shaku-do tipped with gold or red copper, and the whole design is fitted in like a puzzle, and the result is they build up a picture gradually, using coloured alloys, or alloys which may be coloured by the action of a pickle, and they attain the result which is shown in the diagram. The basis is a plate of copper. Here in one place there is a leaf which is not really raised, but a little sunk below the surface of the original plate. The only relief it possesses is obtained by hammering a light variety of gold over it. Then comes a red bud of su-aka, set with its golden points. Here is a shibu-ichi leaf, half of which is of red su-aka, and if you look closely afterwards you will see the bird, or shaku-do, with all its feathers carefully drawn, and the lustrous effect of the plumage produced with really consummate skill by the use of fine lines. Then comes a shibu-ichi flower with a golden centre. This is typical of the work they do; however large or small it may be, they simply inlay these coloured alloys, using generally a sombre base. The beautiful vase, No. 30, 1886, in the South Kensington collection, has all the typical alloys. (Fig. 15, p. 1025.)

The Japanese do not merely trust to obtaining effects by high relief, as is the case with this plate; very often they employ a darker alloy for producing the effect of painting on metal, so to speak, in a very remarkable way. There is one example in Mr. Huish's collection, a knife handle, which presents the effect of a duck's back and wings in comparatively high relief with his neck under water (Fig. 16, p. 1025). He is a shaku-do purple duck, plunging through silvery-grey water, but his body is in high relief, his neck is of a different *nuance*, of tinted shaku-do to the rest of his body, and it is so beautifully let in that it is only in certain lights that you

can see it at all, but it produces exactly the effect of the duck's neck being below the surface of the water. I have not that specimen here, but I have in a sword-hilt, also from the collection of Mr. Huish, some tiny minnows, each about 1-16th of an inch, with minute gold eyes, swimming up a shibu-ichi grey stream, the effect of their being actually below the surface of the water being suggested with marvellous skill. I think at present no

FIG. 15.

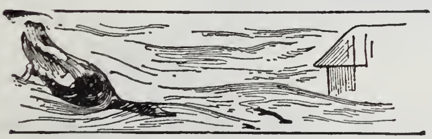

FIG. 16.

The diagram represents a portion of a Japanese knife handle in the collection of Mr. Marcus B. Huish. It consists of *Shibu-ichi*, an alloy containing about equal parts of silver and copper. The duck is of *Shaku-do*, the alloy of copper with from 1 to 5 per cent. of gold. By "pickling," a grey patina is given to the *Shibu-ichi*, and a purple patina to the *Shaku-do* duck, the arrangement being so skilful that the neck of the duck appears to be beneath the water, and is only seen when the handle is held towards the light in certain directions.

European artificer could obtain such a result as that, as it shows the most beautiful effects, not merely of texture but brilliancy and transparency. The colour effect they produce by the use of the pickles—the composition has been already given—but many of the extremely valuable old Chinese bronzes have acquired their tint simply by long exposure to atmospheric influences. If you look, for instance, at No. 160 in the South Kensington bronze cases, it is a Chinese duck of about 1 foot across, if I recollect rightly, purchased about 1876, and it has a green patina, indicating extreme old age, and although

my friend, Mr. Gowland, says the attribution of it on the label to the 3rd century is inaccurate, still it is an extremely old specimen of bronze, which has acquired its green patina by perfectly natural causes, unaided by artificial treatment such as the Japanese always employ in more modern work. Again, there is No. 148, a green gourd, in the South Kensington collection, and No. 79, a vase in the form of two cups, base to base, a beautiful mottled red on a green patina, and I think in this case the red is produced by heating and not by pickling. Then if you look at No. 224 in the Museum, you will see a bronze fish with scales inlaid with silver, which is very instructive.

The Vase, No. 120A, 1878 (Fig. 17), is given on account of its suggestiveness and the simplicity with which the effect is produced. The upper part is of light bronze and the globular portion consists of a series of bands joined with silver studs or rivets. The uppermost band is of red copper, the next is of liver-coloured bronze, the next has a brilliant green patina of carbonate of copper, and this is followed by another bright red layer, and then by one of light bronze, the base being either shibu-ichi or silver.

Fig. 17.

There is one other mode of treatment which I have specially studied, but the South Kensington collection contains only two examples of it, a pair of vases, one of which is shown in Fig. 18. It is a singular combination of banded alloys, and the method by which the combination is produced is shown in Fig. 19. The characteristic alloys employed by the Japanese are taken in thin sheets and soldered together. Conical holes are then drilled partly through the mass, so as to penetrate different layers or strata of the mass, and when the

whole is beaten flat, of course different layers will come to the surface. Another method

Fig. 18.

consists in raising prominences on the front of the plate by punching the back, and these prominences are then filed flat, producing

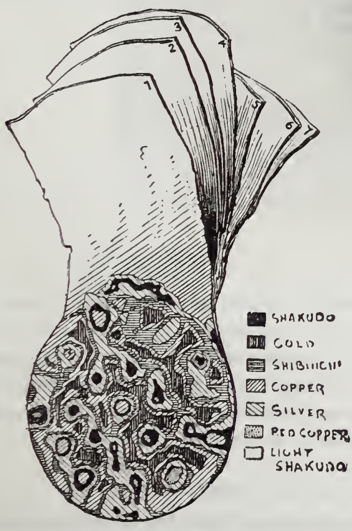

Fig. 19.

banded effects of great beauty and complexity. These alloys are often introduced into the tiniest work, a single bead half an inch in diameter may contain hundreds of layers. The names mizu-nagashi (marble) and moku-me (wood grain) are given to the chief varieties. This pair of vases, one of which is shown in Fig. 18, is one of the few examples in this country. It is not particularly good in form, but is of great merit as regards the manipulative skill displayed in its production. The neck, band, and foot are of shaku-do inlaid with gold, while the body of the vase is of mizu-nagashi, consisting of alternate layers of shaku-do and red copper, and there is a silver panel bearing a bird beautifully wrought in gold and coloured alloys beaten into the silver. The band round the centre is of shaku-do, which has been wrought with fine indentation so as to produce a singularly faithful resemblance to leather.

The South Kensington collection also contains an interesting Vase, No. 72, 1889 (Fig. 20), of old Japanese work in marbled bronze, but the marbling is in the patina alone, for the vase is of solid bronze, and is not made of layers, as in the case just described.

Gold.

With regard to alloys of gold, I do not think that in modern times we make nearly enough use of the very old alloy *electrum*. It occurs native, and was originally regarded as being a distinct metal, of the same order as gold or silver. Lovely coins were struck from nuggets of it B.C. 700. It was prepared artificially also, as is shown by the following sentence:—"As when gold is fused around silver by an experienced man, whom Hephaestus and Pallas Athene have instructed in all kinds of arts, that he may execute graceful works, so did the goddess pour gracefulness around his head and shoulders."* Ultimately, the authors of the Middle Ages applied the word electrum to yellow bronzes, and more especially to brass. I have one analysis of the true, gold-silver electrum, a specimen in the South Kensington Museum:—

No. 28.—A Relic Shrine, or "Stupa," in four parts (incomplete). Gold repousse and chased with conventional ornament in bands. *Burmese.* Discovered in levelling a Budhist Temple at Rangoon in April, 1885. H. 15 in., diam. 12¼ in. 02755.

Analysis.

Gold	72·02
Silver	22·96
Copper	5·24
	100·22

* Od. vi. 232-5, quoted by Schliemann, 258 Ilios, probably manufactured electrum.

This leads me to speak of the extraordinary effect of metals on gold, effects which we are only now beginning to examine. Take, for instance, the action of aluminium on gold. An alloy containing 90 per cent. of gold and 10 per cent. of aluminium is a brilliant white, but if the amount of aluminium be doubled (really 23 per cent.), then a brilliant purple alloy, ruby-coloured in its crystals, is obtained; and from the yellow gold and the grey aluminium we have the most brilliantly coloured alloy which is as yet known. Greenish gold is produced by adding 14 per cent. of silver to pure gold, and blue gold by the presence of a little iron.

Silver.

The peculiar greyish tint often seen on the surface of silver wares or on that of silver copper alloys, and known as "oxidation," is readily produced by immersing the articles in a hot solution of sulphide of potassium.

There is, however, a delicate violet tint which may be imparted to silver by converting its surface into a thin layer of chloride, and then allowing the action of light to stain the

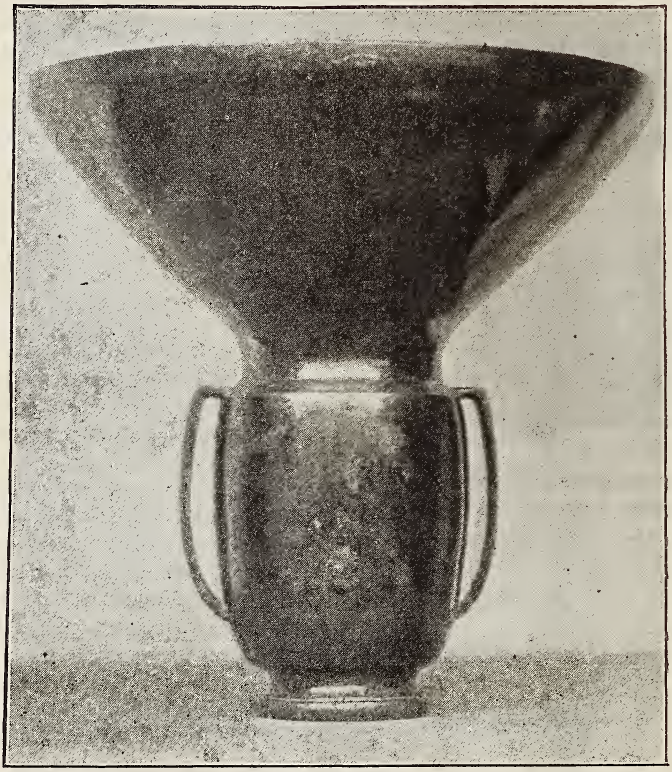

Fig. 20.

chloride violet. Messrs. Christofle* long ago pointed out that this might be done, and Messrs. Tiffany of New York have recently produced some very beautiful articles in this violet-tinted silver.

A little specimen of their work has been placed in the Museum. It has a damascened ornament produced by protecting certain portions of the chloridised silver from the action of light.

* "Comptes Rendus," vol. 73, 1874. 1019.

Old work in *niello* hardly comes within the limits of this lecture, but it may be mentioned that M. Lucien Gaillard of the well-known firm of silversmiths of Paris, has recently produced some articles of great beauty in malleable sulphide of silver.

Nickel.

The specimens of metal work analysed from the Persian and India collections do not contain more than small quantities of nickel; some $\frac{3}{10}$ths per cent. is all that could be found.

This is somewhat remarkable, for there is undoubted evidence of the use of wares in nickel-copper alloys in India. The late Dr. Walter Flight examined several coins of Kings of Bactria, of dates varying from 150 to 246 B.C., and found that they contained nearly the same amount of nickel as the modern nickel coinage of European nations—75 per cent. of copper, and 25 per cent. of nickel. One of the specimens analysed by Flight, a coin of Euthydemus, was found to contain:—

Copper	77·585
Nickel	20·038
Cobalt	·544
Iron	1·048

General Cunningham, in his elaborate paper on the coins of Alexander's successors in the East, inclines to the opinion that the copper-nickel alloy must have come from China. He points out, however, that Quintus Curtius mentions that near the junction of the five Panjâb rivers, Alexander received from the Oxydracœ and Malli a present of 100 talents of white iron (*ferri candidi*), which could not have been tin, as that metal was well-known to the Greeks, and it may very probably have been a white alloy of nickel and copper.

Analysis No. 59 in the report, was made on a chopstick case, of modern Japanese workmanship, which was found to contain 6·14 per cent. of nickel.

No. 59.—Chopstick Case. *Modern Japanese.*

Analysis.

Copper	65·88
Arsenic	Cons. trace.
Lead	·33
Bismuth	Trace.
Iron	·37
Nickel	6·14
Cobalt	·50
Zinc, by diff.	26·78
Gold	Trace.
Silver	Trace.
	100·00

This sample, from my own collection, was an electro-plated one, and was covered with a coating of silver, which was removed prior to analysis. The surface scrapings contained much silver. The colour of the above metal was nearly white.

Antimony.

I have already called attention in the analysis No. 40, to the presence of 2 per cent. of antimony in a variety of brass. At the present day we only know antimony as a brittle metal, but Berthelot* analysed a fragment of a Chaldean vase, which proved to be of pure antimony, so that the ancients must have known some method of making this metal malleable.

Dr. Gladstone† has recently shown that some beads found by Dr. Flinders Petrie in Egypt are of antimony.

Viewing the materials at the command of the art metal worker as a whole, the point I want remembered is this: by the time the elder Pliny, the naturalist, wrote in the first century of our era, and described as well as a cultured gentleman with scientific tastes could, the nature of early metallurgy, that industrial art was itself really far advanced, and the art metal worker had excellent materials, mainly bronze, at his disposal. But the artist was far in advance of the metallurgist, if we only judge by the articles of the most common use found in Pompeiian homes, ordinary kitchen utensils which, as Sir Frederick Leighton says, exhibit an amazing wealth of idea and a high level of executive merit, "each bowl, each lamp, each spoon almost, is an individual work of art, a separate and distinct conception, a special birth of the joy of creation in a genuine artist, the chief characteristic of Pompeiian work being the absence of any ugly thing."

If art metal work is to be revived in this country, it will be well to remember that, while in the time of Pliny the art metal worker produced beautiful things with few metals and alloys, his successor of to-day makes but scanty use of the wealth of materials at his command. In this direction France has little to teach us. Take, for instance, the bust representing *Gallia* in the Luxembourg. It was modelled by M. A. Moreau-Vauthier, and executed by M. L. Falize. The face is of ivory; over a chain armour in black silver there is a breast-plate in two shades of gold, enriched with topaz and emerald. The helmet of gold is relieved by black niello, and there are two straps of brown bronze, which well represent leather, hung from the helmet. The work is excellent, but how greatly the effect might have been heightened, and the interest in the work deepened, if the artist had only employed the Japanese series of alloys. One artist alone, Alfred Gilbert, has employed them, and, of course, with great skill and effect; and as in him the nation possesses a sculptor whose work is equal to the best days of the Italian Rennaissance, we must look to

* "Ann. de Chem. et de Phys.," xii., 1887, p. 135.

† "Proceedings of the Society of Biblical Archæology," March, 1892.

his school for advance in this direction. We may then remove the reproach that we are still far behind the Oriental metal worker. It would appear that neither the purple shaku-do, nor the grey shibu-ichi, are suitable for striking into medals that require even moderate relief; at least, I failed to produce satisfactory medals in either of these alloys, for even the small proportion of gold which, in shaku-do, is added to copper, very materially hardens the copper. Both alloys may, however, be used either in sheets or cast into moulds. The Japanese do use them cast, and it may be well, therefore, to conclude this lecture by a brief account, but little more than an outline, of the method of casting known as *cera perduta*, which suggests an infinite variety of applications for these interesting alloys.* It must be imagined that the bust has been (Fig. 21) modelled in wax (*b*) on a core

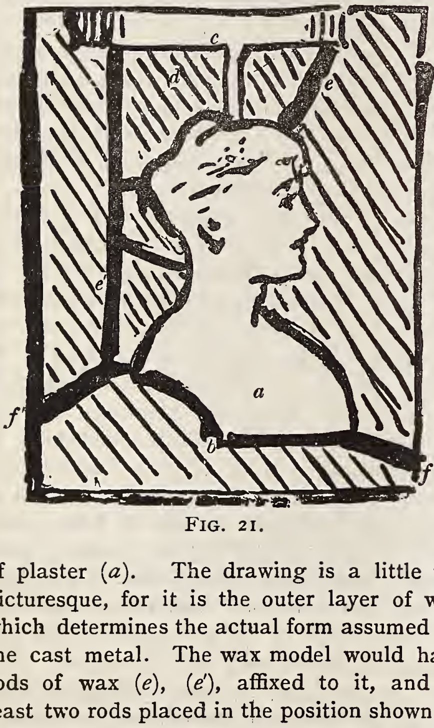

FIG. 21.

of plaster (*a*). The drawing is a little too picturesque, for it is the outer layer of wax which determines the actual form assumed by the cast metal. The wax model would have rods of wax (*e*), (*e'*), affixed to it, and at least two rods placed in the position shown at (*f*), (*f'*). A funnel-shaped rod of wax would be placed above the head, so as to leave the opening or "get" (*c*) through which the metal would be poured. The bust with the rods of wax would then be covered with a mass of plaster (*d*) shown by the cross-hatched lines, and when the mass is firmly set and dry the wax would be melted away by surrounding the entire mould with a fire. The wax will then pour out from the lower orifices (*f*), (*f'*), leaving an empty space wherever it had been. There must be suitable supports to prevent the shifting of the core. The ducts (*f*), and (*f'*), are then closed by plugs, and bronze or other metal is then poured in through the "get" (*c*), filling the spaces left by the wax. The openings (*e*) and (*e'*) serve to allow the air to escape, but they become filled with molten metal, and the rods thus produced have to be cut away from the finished bust. It will be evident that the cautious removal of the plaster of the mould, shown by the cross-hatched lines, will leave a metallic bust in the form of a thin shell investing the core (*a*).

The adoption of this process should afford abundant scope for the extended use of Japanese alloys for which I have so long and so persistently pleaded.

* A sufficient account of this method applied to the casting of medals is given in the Mint Report, 1885, p. 25.

Miscellaneous.

THE PRODUCTION AND USES OF KAPOK FIBRE.

In Indo China, and in the Indian archipelago, the name of "kapok" is given to the setaceous fibre which envelopes the seed of the *Bombax pentandrum* and of the *Eriodendron anfractuosum*, a tree which grows from 90 to 100 feet. Its capsular fruit resembles a small pear, with a tough shell containing seeds about the size of a small pea, of a brownish colour, which are enveloped in a fibrous substance. It is said that the tree commences to yield its fruit and its textile matter from the third year. It thrives in any soil, but it prefers altitudes of about 6,000 feet, and is very sensitive to cold. According to the *Industrie Textile* of Paris, the countries supplying the best kapok are the islands of the Indian archipelago, Java, Bombay, Sumatra, and the Peninsula of Malacca. In the island of Ceylon, the kapok is not of so good a quality, it being generally more powdery and less elastic. The kapok fibres are shrunken and twisted like those of cotton, and, when exposed to the action of fire, emit an odour similar to that of vegetable matter. It appears to have been first introduced into the London market in 1851, having been brought there from the Netherlands, but it attracted little attention. In Australia, however, it soon received favourable notice, and quantities of it were obtained from Ceylon. In Australia kapok has for some time past been used in the decorative industries, and in 1884 1,000 bales were imported. In 1886, this quantity had increased to 8,600 bales, chiefly obtained from Java. This island in the Indian

Ocean produces the finest description of kapok, as the quantity obtained there is the cleanest, the least compressed, and consequently the most elastic. That of the East Indies, less elastic, is often stained by the oil produced by the breaking of the seed. Recently, however, this difficulty has been obviated by the use of ginning machines. Kapok is used in preference to cotton for wadding and for cushions. Stuffs are made with it in imitation of beaver, and it is used for making hats, for mixing with hare and rabbit skins, and for making up into turbans, cloaks, &c. Experiments have also been made with it for use in dressing wounds. Kapok may also be used in preparing fulminating power, after treatment by nitric acid. This kapok, after treatment by nitric acid, mixed with alcohol, yields the reduced fibre which, variously coloured, furnishes a solution of vegetable silk which solidifies in water, and may be spun and then mixed with silk from silk-worms. The tree which yields this kapok, and which is called *randon* in Java, is planted on the high roads, so that its straight trunk may be used as a telegraph pole. The wood is light and can be used for making boats and for the framework for fishing nets. From the bark exudes a description of gutta-percha, and from the trunk of the tree a species of gum is obtained, soluble in water, of a disagreeable taste, and which is used by the natives as a medicine for intestinal complaints, such as dysentery and diarrhœa. From the seeds an oil is obtained by pressure, which is more appreciated than cotton seed oil, and which is equally useful in lubricating machinery. The thread measures from 135 to 150 millimètres in length, and this same fibre treated with alcohol and dried, loses 12 per cent. of its weight.

General Notes.

The National Wealth of Bulgaria.—Her Majesty's Consul-General at Sofia says that the population of Bulgaria, as recorded in the returns for 1892, amounted to over 3,300,000. Statistics on all subjects in that country are still in their infancy, but an eminent Bulgarian has estimated the average annual income of the country for the last four years, derived from agriculture and industry, to amount to £33,000,000. Of this amount agriculture is credited with £22,000,000, which includes grain of all kinds, tobacco, cattle, wine, products of forest and pasture lands, &c., and industries are valued at £11,000,000. Taking the population at 3,300,000, this sum would give an annual income per head for man, woman, and child of about £10. When the low cost of living in Bulgaria is taken into consideration, together with the simple food and habits of nineteen-twentieths of the population, this would account for the fact that real property may be said to be absolutely non-existent. According to the most reliable calculations, the capitalised wealth of Bulgaria may be stated to be £168,040,000, including land, buildings, railways, and other public works, cattle, bullion, &c. From this should, however, be deducted £6,120,000, being the portion of Bulgarian loans held by foreigners, leaving a sum of £161,920,000 to represent the capitalised wealth of the country, or a little more than £49 per head of the population, being about five years value of the average national income.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 13...Scottish Society of Arts, 117, George-street, Edinburgh, 8 p.m. Opening Address by the President.

Cleveland Institute of Engineers, Middlesborough, 7½ p.m. Presidential Address.

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Opening Address by the President, Mr. Clements R. Markham.

Tuesday, Nov. 14...Civil Engineers, 25, Great George-street, S.W., 8 p.m. Opening address by Mr. Alfred Giles, President.

Photographic, 5A, Pall-mall East, S.W., 8 p.m. 1. Mr. H. W. Hughes, "Photography in Coal Mines." 2. Prof. W. K. Burton, "The Range of Light Impinging on a Plate during Exposure in the Camera."

Anthropological, 3, Hanover-square, W., 8½ p.m. 1. Exhibition of a Series of Stone, Flint, and other Implements, by Prof. Boyd Dawkins. 2. Prof. Boyd Dawkins, "The Relation of the Palæolithic to the Neolithic Period." 3. Mr. A. M. Bell, "The Flint Implements of the Chalk Plateau of Kent."

Colonial Inst., Whitehall Rooms, Whitehall-place, S.W., 8 p.m. The Earl of Onslow. "State Socialism, and Labour Government in Antipodean Britain."

Wednesday, Nov. 15—SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Opening Address of 140th Session by Sir Richard Webster, Chairman of Council.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Frederick J. Brodie, "The Great Drought of 1893 and its attendant Meteorological Phenomena." 2. Mr. William Marriott, "Thunder and Hail Storms over England and the South of Scotland, 8th July, 1893."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. W. West, "New British Fresh-water Algæ." 2. Mr. T. F. Smith, "On the Value of Aperture in Microscopical Research (with lantern)." 3. Mr. G. Sandeman, "A Parasitic Disease in Flounders."

Thursday, Nov. 16...Linnean, Burlington-house, W., 8 p.m. 1. Rev. George Henslow, "Origin of Plant Structure through Self Adaptation to the Environment exemplified by Desert and Xerophilous Plants." 2. Mr. W. F. Kirby, "Catalogue of the described *Neuroptera Odonata* (Dragonflies) of Ceylon, with Descriptions of new Species."

Chemical, Burlington-house, W., 8 p.m. Professor Percy Fraanklnd and Mr. John Macgregor, (1) "The Normal Butyl, Heptyl, and Octyl Esters of Active Glyceric Acid;" (2) "The Ethereal Salts of Dacetyl-Glyceric Acid in their relation to Optical Activity." And other papers.

Sanitary Institute, 74A, Margaret-street, W., 8 p.m. Dr. J. T. Arlidge, "Mineral (non-metallic) Dusts in the Manufactory of Pottery, &c."

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the receipt of the following Transactions of Societies and Periodicals.

TRANSACTIONS, &c.

American Academy of Arts and Sciences, Proceedings and Memoirs.
American Chemical Society, Journal.
American Institute of Electrical Engineers, Transactions.
American Philosophical Society, Proceedings and Transactions.
American Society of Civil Engineers, Transactions and Proceedings.
Association of Engineering Societies, Journal.
Australasian Association for the Advancement of Science, Report.
Bath and West of England Society, Journal.
Birmingham Philosophical Society, Proceedings.
British Association for the Advancement of Science, Report.
British Guiana, Royal Agricultural and Commercial Society of, Journal.
British Horological Institute, Horological Journal.
Camera Club, Journal.
Canada, Royal Society of, Proceedings and Transactions.
Canadian Institute, Transactions.
Canadian Society of Civil Engineers, Transactions.
Central Chamber of Agriculture, Proceedings.
Chemical Society, Journal.
Cleveland Institution of Engineers, Proceedings.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institute, Journal.
Geneva, Société des Arts, Bulletin de la Classe d'Industrie et de Commerce.
Geological Society, Quarterly Journal.
Glasgow Philosophical Society, Proceedings.
Incorporated Gas Institute, Transactions.
India, Geological Survey of, Memoirs, Records and Palæontologia Indica.
Indian Meteorological Memoirs.
Institute of Bankers, Journal.
Institute of Brewing, Transactions.
Institute of Patent Agents, Transactions.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Electrical Engineers, Journal.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Jamaica, Institute of, Journal.
Japan, College of Science, Imperial University, Journal.
Junior Engineering Society, Record of Transactions.
Kew Gardens Bulletin.
Linnæan Society, Journal.
Liverpool Polytechnic Society, Journal.
London Association of Foremen Engineers and Draughtsmen, Publications.
London Chamber of Commerce, "Commerce."
Lyon, Société des Sciences Industrielles, Annales.
Manchester Literary and Philosophical Society, Memoirs and Proceedings.
Manitoba Historical and Scientific Society, Papers.
Munich, Polytechnischer-Verein, Bayerisches Industrie-und-Gewerbeblatt.
National Indian Association, "The Indian Magazine."
Nederlandsche Maatschappij ter Bevordering van Nijverheid, Tidjschrift.
New South Wales, Royal Society, Journal and Proceedings.
New York Academy of Sciences, Annals and Transactions.
North-East Coast Institution of Engineers and Shipbuilders, Transactions.
Nova Scotian Institute of Natural Science, Proceedings and Transactions.
Paris Conservatoire des Arts et Metiers, Annales.
——, Société de Geographie Commerciale, Bulletin.
Patent-office, Illustrated Official Journal.
Pharmaceutical Society, Journal and Transactions.
Philadelphia, Academy of Natural Sciences, Proceedings.
————, Engineers' Club of, Proceedings.
Photographic Society of Great Britain, Journal.
Physical Society of London, Proceedings.
Quekett Microscopical Club, Journal.
Royal Agricultural Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Annual Report.
Royal Geographical Society, The Geographical Journal.
Royal Institute of British Architects, Journal of Proceedings and Transactions.
Royal Institution of Cornwall, Journal.
Royal Institution of Great Britain, Proceedings.

Royal Irish Academy, Transactions and Proceedings.
Royal Meteorological Society, Quarterly Journal.
Royal National Life Boat Institution, "The Life Boat."
Royal Scottish Society of Arts, Transactions.
Royal Society, Philosophical Transactions and Proceedings.
Royal Society of Edinburgh, Transactions and Proceedings.
Royal Statistical Society, Journal.
Royal United Service Institution, Journal.
Sanitary Institute, Transactions.
Société d'Encouragement pour l'Industrie Nationale, Bulletin.
Société Internationale des Electriciens, Bulletin.
Société Nationale d'Acclimatation de France, Revue.
Society of Antiquaries, Archæologia and Proceedings.
Society of Architects, Proceedings.
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
Society of Dyers and Colourists, Journal.
Society of Engineers, Transactions.
Society of Public Analysts, "The Analyst."
South Wales Institute of Engineers, Proceedings.
Tasmania, Royal Society of, Papers and Proceedings.
Victoria Institute, Journal of the Transactions.
Western Pennsylvania, Engineers' Society of, Proceedings.
Württemburg, Königliche Centralstelle für Gewerbe und Handel, Jahresberichte.

PERIODICALS.

Twice a Week.

Chemiker-Zeitung.

Weekly.

Accountant.
Amateur Photographer.
American Exporter.
American Architect and Building News.
American Gas Light Journal.
American Manufacturer and Iron World.
Architect.
Architecture and Building (New York).
Athenæum.
Bradstreet's.
British Architect.
British Journal of Photography.
Builder.
Building News.
Capitalist.
Chemical News.
Chemist and Druggist.
Civil Service Competitor.
Colliery Guardian.
Colonies and India.
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